PATENT ABSTRACTS OF JAPAN

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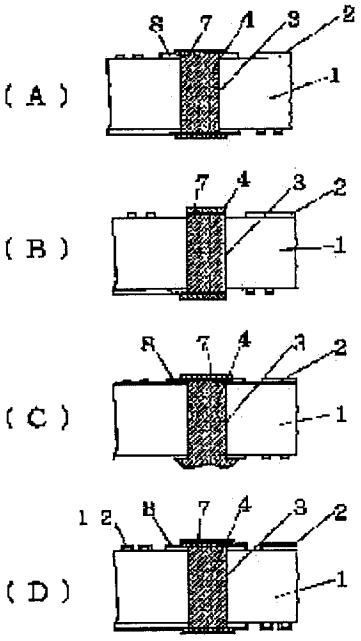
(54) CIRCUIT BOARD

(57)Abstract:
PURPOSE: To improve electrical contact between a through hole part and a circuit pattern, by filling a through hole with a hardening conductive material in a way that the same horizontal face as the circuit pattern is formed, and making a conductive pattern cover the contact part between the hardened part and the circuit pattern.
CONSTITUTION: A through hole 3 is filled with a conductive material 4 to form a through hole part with the same face as both sides or at least one face of the circuit pattern 2. A conductive pattern 7 made of hardening conductive material is formed with uniform thickness at a contact part between the through hole part and the surface circuit pattern 2 so that the conductive pattern 7 covers the contact part. Then, the through hole part and the surface circuit pattern 2 are connected electrically to each other. In addition, the circuit pattern 2 connected to the through hole part may have a land part 8 and preferably, the conductive pattern 7 covering the land part 8 is formed.



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CLAIMS

[Claim(s)]
[Claim 1]In a required place of electric connection between circuit patterns which consist of an insulating substrate by which a circuit pattern was formed in both sides, and exist in both sides of this insulating substrate. A breakthrough for through holes which penetrates this insulating substrate is provided, this breakthrough for through holes is filled up with conductive material, and this circuit pattern and a through hole part which has the same flat surface substantially are formed, And the circuit board, wherein an electric conduction pattern which consists of a cured body of hardenability conductive material of uniform thickness which covers a connection section of this through hole part and a circuit pattern is formed.
[Claim 2]Are the circuit board which consists of a layered product of two or more insulating substrates, and it comes to form a circuit pattern between the at least 1 surface of this layered product, and two or more insulating substrates, When a circuit pattern is formed between a circuit pattern formed in the surface of this layered product, and circuit patterns formed between insulating substrates, or in both the surfaces of this layered product, A breakthrough for through holes which penetrates this layered product is provided in a part among both surface circuit patterns to be connected electric, A circuit pattern which this breakthrough for through holes was filled up with conductive material, and was formed in the surface of this layered product, and a through hole part which has the same surface substantially are formed, And the circuit board, wherein an electric conduction pattern which consists of a cured body of hardenability conductive material of uniform thickness which covers a connection section of this through hole part and a circuit pattern formed in the surface is formed.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the new circuit board. In the circuit board which has a circuit pattern to both sides in detail, or the circuit board which has a circuit pattern between the at least 1 surface of a layered product, and two or more insulating substrates, When carrying out by providing the through hole part which consists the flow between these circuit patterns of a cured body of hardenability conductive material, it is related with the circuit board which can be carried out often [reliability] and simple.
[0002]
[Description of the Prior Art]Generally, the flow of the circuit pattern of the rear surface in the circuit board in which the circuit pattern was formed to both sides is performed via a through hole part. As a manufacturing method of the circuit board which has this through hole part, conventionally, (b) Form a breakthrough in the insulating substrate which has a conductive layer to both sides by drilling, the method of forming a circuit pattern by etching this conductive layer, after giving electroless plating and electroplating to this breakthrough -- or, (**) Etch this conductive layer into it, form a circuit pattern in it, and rank second to it, after forming the breakthrough for through holes in the insulating substrate which has a conductive layer to both sides by drilling or punching, Generally the method of forming the through hole which filled up with and hardened the hardenability conductive material represented by copper paste and silver paste to this breakthrough by screen printing or the pin inserting method and where it was filled up with conductive material, etc. are known.
[0003]Especially the manufacturing method of the circuit board of above (b) is performed industrially for many years.
The present mainstream is occupied.

[0004]
[Problem(s) to be Solved by the Invention]However, in order to raise the reliability of a through hole part, it is necessary to perform plating over 2 times or more, and in the manufacturing method of the circuit board of the above-mentioned (b), it cannot necessarily be said to be an advantageous method in respect of cost. Since electroplating is performed all over the circuit board, the thickness of a conductive layer becomes uneven and there is a possibility that variation may arise, in the case of etching for pattern formation. Therefore, it has the fault that the correspondence to the circuit board which has a fine pattern is difficult.
[0005]Since the manufacturing method of the circuit board of the above-mentioned (**) has unnecessary electroless plating and electroplating into the breakthrough for through holes, and it has the features, like a manufacturing process is short, demand is growing in recent years, but. The through hole part produced by being filled up with conductive material needs to fill up even the circumference of the breakthrough for through holes with conductive material so that it may project rather than the flat surface of epiboly and the circuit board, in order to secure the reliability of the electric connection with the circuit pattern linked to this. As a result, unevenness of the substrate face by the projected conductive material becomes an obstacle of soldering paste printing at the time of mounting of a surface mounted device, and the obtained circuit board serves as hindrance which connects a surface mounted device with sufficient reliability.
[0006]After filling up and hardening on the other hand that this invention persons should improve the circuit board of the above-mentioned (**) so that hardenability conductive material may be projected in the breakthrough for through holes, The circuit board which ground so that the same surface as the conductive layer in which the lobe which consists of conductive material was provided to both sides of the insulating substrate might be formed, formed the through hole part, etched the conductive layer and subsequently formed the circuit

pattern was provided. Formed the plating layer common to a conductive material [of a through hole part], and conductive layer top in this case, and performed etching of the conductive layer after that, the circuit pattern was made to form, and it proposed also about a means to improve the reliability of the electrical link of this circuit pattern and this through hole part.

[0007]Although the circuit board obtained by the described method also has little unevenness of a substrate face, and soldering paste printing at the time of mounting of a surface mounted device can also be performed good and it can connect a surface mounted device with sufficient reliability, The plating layer needed to be further formed on the conductive layer, and although it was not to the circuit board of said (b), in formation of a fine pattern, it had some problem.

[0008]

[Means for Solving the Problem]This invention persons repeated research wholeheartedly that the above-mentioned problem in the circuit board which has a through hole part should be solved.

[0009]As a result, a through hole part which a breakthrough for through holes is filled up with a conductive substance, and has the same flat surface as a surface circuit pattern is formed, The circuit board in which an electric conduction pattern of uniform thickness by hardenability conductive material was formed so that a connection section of this through hole part and a surface circuit pattern might be covered, Improvement in the reliability of an electrical link of this through hole part and a circuit pattern of the surface linked to this can be aimed at very effectively, Since formation of this electric conduction pattern can be performed by simple methods, such as printing, and thickness of a conductive layer is not affected compared with a means by plating, It does not have an adverse effect on etching in formation of a circuit pattern, either, finds out that it can fully respond also to an advanced fine pattern, and came to complete this invention.

[0010]Namely, this invention consists of an insulating substrate by which a circuit pattern was formed in both sides, In a part [need / between circuit patterns which exist in both sides of this insulating substrate / electric / to be connected]. A breakthrough for through holes which penetrates this insulating substrate is provided, this breakthrough for through holes is filled up with conductive material, and this circuit pattern and a through hole part which has the same flat surface substantially are formed, And it is the circuit board, wherein an electric conduction pattern which consists of a cured body of hardenability conductive material of uniform thickness which covers a connection section of this through hole part and a circuit pattern is formed.

[0011]

[Embodiment of the Invention]Hereafter, although this invention is explained still in detail according to an accompanying drawing, this invention is not limited to these accompanying drawings at all. The typical mode of the circuit board of this invention was shown in drawing 1 and drawing 2.

[0012]In drawing 1, the insulating substrate 1 in particular is not restricted, but can be used without restriction of what has publicly known construction material and structure. For example, a paper base-phenol resin laminated circuit board, a paper base-epoxy resin laminated circuit board, A paper base-polyester resin laminated circuit board, a glass base material-epoxy resin laminated circuit board, A paper base-Teflon-resin laminated circuit board, a glass base material-polyimide resin laminated circuit board, A glass base material-BT (bismaleimide triazine) resin resin laminated circuit board, The metal system insulating substrate which covered and carried out the insulation process of the metal, such as flexible substrates, such as synthetic resin bases, such as a composite resin substrate, polyimide resin, polyester resin, aluminum, iron, stainless steel, with the epoxy resin etc., or a ceramics board is mentioned.

[0013]When using the layered product of two or more insulating substrates in the circuit board of this invention, the formation method in particular of this layered product is not limited. Usually, the method of laminating the insulating substrate to which the circuit pattern was given if needed is adopted, and, generally the pin lamination method and mass lamination method which are laminated on both sides of prepreg between insulating substrates are used suitably. The number of layers of an insulating substrate is determined if needed for a pattern. A circuit pattern is formed between both the surfaces of this layered product or the 1 surface, and two or more insulating substrates.

[0014]The circuit board of this invention has a circuit pattern to the both sides, when the number of insulating substrates is one, and when an insulating substrate is a layered product of two or more sheets, it has a circuit pattern between the at least 1 surface and two or more insulating substrates. As the above-mentioned circuit pattern, publicly known patterns, such as a circuit pattern, a land, and a pad section, are formed if needed.

[0015]Although the construction material in particular of the circuit pattern formed is not restricted, copper, nickel, etc. will be mentioned if typical construction material is illustrated. Although not restricted in particular about the thickness of the above-mentioned circuit pattern, either, generally a thickness of 5-70 micrometers is

suitable.
[0016]In this invention, the breakthrough 3 for through holes, In the required place of the electric connection between the circuit patterns formed in the both sides when the number of insulating substrates was one, when insulating substrates are two or more layered products, again, Between the circuit pattern formed on the surface of the layered product, and the circuit patterns formed between insulating substrates, Or when the circuit pattern is formed in both the surfaces of this layered product, it is provided in the required place of the still more nearly electric connection between the circuit pattern of both the surfaces of this layered product, and the circuit pattern formed between insulating substrates between both surface circuit patterns.
[0017]The path in particular of this breakthrough 3 for through holes is not a restricting thing, and can be set up arbitrarily. In this invention, more than the aperture that is a grade which can be filled up with conductive material can usually choose preferably the path of the above-mentioned breakthrough for through holes from 0.2 mm - 2 mm 0.1 mm or more. And in this invention, since it is possible to take a flow certainly even if it is a starting very small aperture, it is effective in the formation of a fine pattern which carries out a postscript. In this invention, the above-mentioned breakthrough 3 for through holes is filled up with the conductive material 4, and the circuit pattern (it is described as a surface circuit pattern below) 2 of both sides or the at least 1 surface and the through hole part which has the same flat surface substantially are formed in it. It is fixed to the breakthrough 3 for through holes, and the construction material of this conductive material 4 will not be restricted especially if it has conductivity. In this invention, the hardenability conductive material 9 which gives the cured body which has conductivity after hardening from the ease of the restoration to the breakthrough 3 for through holes, the field of productivity, etc. is preferred in the manufacturing process of the circuit board.
[0018]As the above-mentioned hardenability conductive material 9, the publicly known hardenability conductive material which mixed the powdered electrical conducting material which consists of gold, silver, copper, nickel, lead, carbon, etc., and the thermosetting resin of cross-linking, such as an epoxy resin and phenol resin, with the organic solvent as occasion demands, and was made into paste state can be used. The etching reagent used for etching out of such hardenability conductive material, For example, a ferric chloride etching reagent, a cupric-chloride etching reagent, an ammonium persulfate etching reagent, It is preferred to choose and use what gives the cured body which is not substantially dissolved by etching reagents, such as a sodium persulfate etching reagent, a potassium persulfate etching reagent, hydrogen peroxide / sulfuric acid etching reagent, and an alkaline etching reagent that uses ammonium sulfate complex ion as the main ingredients.
[0019]As for the above-mentioned hardenability conductive material 9, in order to obtain good through hole resistance, it is preferred to adjust selection of an electrical conducting material and the amount used so that the electrical resistance after hardening may become below in $1x10^{-2}$ omega-cm.
[0020]Forming so that the conductive material 4 and the surface circuit pattern 2 with which the breakthrough 3 for through holes was filled up may make the same flat surface substantially in this invention, Soldering paste printing at the time of mounting of the surface mounted device to the circuit board obtained can be performed good, It is important in order to connect a surface mounted device with sufficient reliability, and it is required in order to form certainly the electric conduction pattern 7 which consists of a cured body of the hardenability conductive material formed so that the connection section of this through hole part and the surface circuit pattern 2 may be covered with high reliability with sufficient accuracy.
[0021]In this invention, the electric conduction pattern 7 of the uniform thickness by the cured body of hardenability conductive material is formed so that the connection section of the above-mentioned through hole part and the surface circuit pattern 2 may cover this connection section, and electric connection of a through hole part and a surface circuit pattern is made.
[0022]By covering the connection section of a through hole part and the surface circuit pattern 2 by uniform thickness with the above-mentioned electric conduction pattern 7, a simple means enables it to raise certainly the reliability of the electrical link of a through hole part and the surface circuit pattern 2. This means is the purpose of raising the reliability of the electrical link of a through hole part and the surface circuit pattern 2, It is the point that the surface of the circuit board is maintained smoothly, and is very more advantageous in the accuracy of a post process, mounting of parts, etc. than in a means by which it is filled up with the above mentioned conventional conductive material so that it may project rather than the flat surface of epiboly and the circuit board even around the breakthrough for through holes.
[0023]A through hole part and a circuit pattern by a plating layer for the purpose in a wrap means. The difference of a coefficient of thermal expansion of the cured body of conductive material and plating layer with which the through hole part was filled up is large, heat stress concentrates on this plating layer at the time of a reflow of component mounting, and there is a possibility of leading to the defective continuity of a through hole

depending on the case. On the other hand, if the conductive material with which a through hole part is filled up, and the thing to which the coefficient of thermal expansion of these cured bodies approximates the through hole part and the circuit pattern as wrap hardenability conductive material are used, the heat stress of this invention generated at the time of a reflow is small, and it can acquire high connection reliability. Since it does not have the plating layer which caused dispersion in etching, it is advantageous about the formation accuracy of a circuit pattern.

[0024]The connection section of a through hole part and the surface circuit pattern 2 with the above-mentioned electric conduction pattern 7 a wrap mode, Although what is necessary is just a mode which covers the part where the periphery and the surface circuit pattern 2 of a through hole part contact at least and in which an electric conduction pattern exists, a wrap mode is preferred in the peripheral area of the surface circuit pattern which a through hole part connects to all the surfaces and a through hole part substantially more preferably. Although the width of the peripheral area of this circuit pattern is based on the circuit width of a circuit pattern, etc., if reliability is taken into consideration, generally it is preferred to determine at 0.05 mm or more from a contact boundary line with this through hole part.

[0025]As shown in (A) of drawing 1, in order to raise reliability, it is still still more preferred to form so that the land 8 may be formed in the circuit pattern 2 linked to a through hole part and the above-mentioned electric conduction pattern may be covered also including this land. Although 0.05 mm or more is good as for the length from the circumference of a through hole part, if the wiring density of the circuit board is taken into consideration, it is preferred for the size of this land to design so that it may be set to 2 mm or less. Of course, as shown in (B) of drawing 1, even if it is a mode which does not form a land, it is possible to fully secure reliability.

[0026]As the above-mentioned electric conduction pattern 7 shows the connection section of a through hole part and the surface circuit pattern 2 to drawing 6 also in which mode of a wrap, the shape of the connection section of a through hole part and this surface circuit pattern can also be formed what is called in the shape of a teardrop. It enables the area of the surface circuit pattern covered with this electric conduction pattern 7 to improve the reliability of a terminal area more also in the mode which does not provide increase and the land especially shown in (B) of drawing 1 by forming the above-mentioned connection section in the shape of a teardrop.

[0027]As shown in (A) of above-mentioned drawing 1, the land 8 can be formed in the surface circuit pattern 2, and in the mode formed so that the above-mentioned electric conduction pattern 7 may be covered also including this land 8, as shown in drawing 7, this electric conduction pattern can also be formed in doughnut form except for the central part of a through hole part. Thus, by forming the electric conduction pattern 7 in doughnut form, the amount of the hardenability conductive material used used for this electric conduction pattern that carries out a postscript can be reduced, and it is economically advantageous.

[0028]In this invention, the electric conduction pattern 7 formed so that the connection section of the above-mentioned through hole part and this surface circuit pattern 2 may be covered needs to be uniform thickness. That is, by making this electric conduction pattern uniform, the stable through hole resistance can be acquired and the yield at the time of manufacture improves. When this electric conduction pattern has homogeneity about thickness, printing of soldering paste performed in mounting of parts, etc., formation of an overcoat layer, etc. can be performed with sufficient accuracy, and the connection reliability of a surface mounted device, etc. can be improved.

[0029]On this electric conduction pattern by making the above-mentioned electric conduction pattern 7 into uniform thickness, a surface mounted device is carried in the stable state. Therefore, since it becomes possible to carry out direct continuation of the surface mounted device on this electric conduction pattern, component-mounting density can be raised.

[0030]Although it is not restricted, especially the thickness of the above-mentioned electric conduction pattern 7 has a preferred thickness of 5 micrometers - 100 micrometers, when the reliability of a through hole and the printing nature of soldering paste are taken into consideration. Since component mounting can carry out very easily if it controls in the range of 5-50 micrometers, it is still more suitable. As for dispersion in the thickness of this electric conduction pattern 7, although it is dependent on the size of the formation method of this electric conduction pattern 7, or the terminal area of a surface mounted device, it is preferred to adjust so that it may become **30% or less to the average thickness.

[0031]Although the thing of the hardenability conductive material and same material which are used as conductive material with which said breakthrough for through holes is filled up can also be used for the construction material of the electric conduction pattern 7 formed in this invention so that the connection

section of the above-mentioned through hole part and this surface circuit pattern 2 may be covered, It is more preferred than the conductive material with which the breakthrough for through holes is filled up especially to use the hardenability conductive material which gives the cured body provided with moisture resistance.
[0032]By forming the electric conduction pattern 7 provided with this moisture resistance, the circuit board which has the through hole part excellent in reliability, especially moisture resistance can be obtained.
[0033]The hardenability conductive material which gives the above-mentioned damp-proof cured body can be used choosing it from publicly known hardenability conductive material. For example, although not restricted especially as an electrical conducting material included in the hardenability conductive material which gives the above-mentioned damp-proof cured body, it is hard to oxidize, and although metal, such as gold with a low specific resistance value, silver, and copper, and resistance are a little high, the carbon etc. which are not influenced by oxidation at all can use it conveniently.
[0034]If insulation reliability with the adjoining surface circuit pattern 2 is taken into consideration in the above-mentioned electrical conducting material, it is preferred to adopt metal with little migration. Especially, copper is considered from conductivity, the workability of antioxidizing, cost, etc., and is used suitably.
[0035]In order to prevent oxidation of metal, such as copper contained in the above-mentioned hardenability conductive material, what mainly uses the resol type phenol resin which gives a reducing atmosphere at the time of heat curing as a binder component is more preferred.
[0036]When above-mentioned resol type phenol resin is used as hardenability conductive material with which the breakthrough 3 for through holes is filled up, Although a void occurs in a through hole under the influence of the moisture and formalin by which it is generated as a by-product at the time of heat curing of this resin and there are a fall of the conductivity of the cured body of the hardenability conductive material with which it filled up in the through hole, and a possibility of also spoiling the circuit reliability of this through hole neighborhood further, In this invention, it can be effectively used in formation of the electric conduction pattern 7.
[0037]As described above on the other hand, although the hardenability conductive material 9 in particular with which the breakthrough 3 for through holes is filled up is not limited, its thing using the epoxy resin system binder which becomes from few epoxy resins and hardening agents of generating of a by-product as a binder component at the time of hardening of a binder is preferred. The hardenability conductive material using this binder is a little inferior to the hardenability conductive material which mainly uses above-mentioned resol type phenol resin as a binder in moisture resistance. However, according to the above-mentioned mode of this invention, it is possible to be able to protect scarce hardenability conductive material to this moisture resistance by the moisture resistance of the electric conduction pattern 7, and to improve reliability to it further.
[0038]Among the construction material of the hardenability conductive material 9 with which the above-mentioned breakthrough for through holes is filled up, as for a metallic component, although restriction in particular is not carried out, if insulation reliability with an adjoining through hole is taken into consideration, it is preferred to adopt metal with little migration. Especially, copper is considered from conductivity, the workability of antioxidizing, cost, etc., and is used suitably.
[0039]The breakthrough 3 for through holes is filled up with the hardenability conductive material 9 using the binder of the epoxy resin system with little generating of a by-product at the time of hardening of a binder in this invention, To the hardenability conductive material formed so that the conductive material 4 inside a through hole may be formed and the connection section of a through hole part and the surface circuit pattern 2 may be covered. Resol type phenol resin is used as the binder main ingredients, and the mode using the damp-proof copper paste which used copper with little migration as the metallic component is recommended most.
[0040]By forming a through hole part with this composition, the circuit board which a defect does not exist in the inside of a through hole, and has a reliable through hole part can be obtained.
[0041]In this invention, other portions can adopt publicly known art and are not restricted in particular. For example, portions other than the contact button of a circuit pattern, With publicly known insulating resin (resist), it may protect by forming an overcoat layer, and the circuit pattern which consists of plating layers, such as copper, can also be formed via the insulating layer formed in the surface of this surface circuit pattern 2 except for the contact button by the publicly known means.
[0042]When a surface mounted device is mounted only in one side, only the field where a surface mounted device is mounted can also be made into the mode of the circuit board of this invention. That is, the field where parts are not mounted can change the conventional conductive material into the state where the circumference of the breakthrough for through holes was filled up with epiboly and conductive material so that it might project from the flat surface of the circuit board, and can also adopt the mode of the circuit board of this invention only as the field which mounts parts.

[0043]In the construction material of the electric conduction pattern 7 formed again so that the connection section of the above-mentioned through hole part and the surface circuit pattern 2 may be covered. If solder adopts after hardening the hardenability conductive material which gives the cured body which can form the cured body, or nickel and gilding usually used for terminal plating etc. which can carry out a coat, Since direct continuation of the surface mounted device can be carried out on the electric conduction pattern 7 (through hole part), it becomes still more possible to improve component-mounting density. In order that the shape in particular of this electric conduction pattern in the above-mentioned aspect may raise the stability of connection of this electric conduction pattern and a surface mounted device as shown in drawing 8 although it is not limited, the thing of a pad section for which all are almost covered and a pad section is made into flat shape is preferred from the ease of mounting of a surface mounted device. Since the mode which forms this electric conduction pattern also about all the pad sections which carry a mounting component is carried where a surface mounted device is stabilized more, it is still more desirable from the ease of mounting of a surface mounted device.
[0044]Although the mode in particular of the circuit board of this invention is not restricted, it shows drawing 1 and drawing 2 a typical mode.
[0045]The aspect shown in (A) of drawing 1 forms the land 8 in the surface circuit pattern of both sides linked to a through hole part, and it forms it so that the electric conduction pattern 7 may be covered also including this land.
[0046]The aspect shown in (B) of drawing 1 forms the electric conduction pattern 7 without forming the land 8 in the surface circuit pattern of both sides linked to a through hole part.
[0047]The aspect shown in (C) of drawing 1 forms the land 8 in the surface circuit pattern of both sides linked to a through hole part, and it forms it so that only one side may cover the electric conduction pattern 7 also including this land.
[0048]The aspect shown in (D) of drawing 1 forms the land 8 in the surface circuit pattern of both sides linked to a through hole part, it is formed so that an electric conduction pattern may be covered also including this land, and it provides nickel and a gilding layer on a surface circuit pattern part and an electric conduction pattern part. Thereby, when an electric conduction pattern is solder wettability bad conductive paste, a surface mounted device can be carried on this electric conduction pattern.
[0049]The aspect shown in (A) of drawing 2 is the circuit board which consists of a layered product of three insulating substrates, and it is a thing when the surface circuit pattern 2 is formed between these insulating substrates and in both the surfaces of this layered product, The land 8 is formed in the surface circuit pattern 2 linked to a through hole part, and it forms so that an electric conduction pattern may be covered also including this land.
[0050]The aspect shown in (B) of drawing 2 and (C) is the circuit board which consists of a layered product of three insulating substrates, and it is a thing when the surface circuit pattern 2 is formed between these insulating substrates and in the 1 surface of this layered product, The land 8 is formed in the surface circuit pattern 2 linked to a through hole part, and it forms so that the electric conduction pattern 7 may be covered also including this land.
[0051]Although the manufacturing method in particular of the circuit board of this invention is not restricted, if a typical manufacturing method is illustrated, the method shown in drawing 3, drawing 4, and drawing 5 will be mentioned.
[0052]Namely, the breakthrough 3 for through holes is formed in a part [need / as the circuit board of this invention is shown in drawing 3 / between the surface circuit patterns 2 formed in both sides of the (a) insulating substrate 1 / electric / to be connected], (b) After making this breakthrough 3 for through holes fill up with and harden the hardenability conductive material 9 which gives the cured body which has conductivity, (c) Grind substantially smoothly the surface constituted with the surface circuit pattern 2 and the conductive material 4 which were formed in both sides of an insulating substrate, and (d) Rank second, It can obtain by applying hardenability conductive material and forming the electric conduction pattern 7 of uniform thickness so that the connection section of this through hole part and the above-mentioned surface circuit pattern 2 may be covered.
[0053]As other methods which do not form the surface circuit pattern 2 in both sides of an insulating substrate beforehand, as shown in drawing 4, (a) Form the breakthrough 3 for through holes in the insulating substrate 1 which has the conductive layer 5 to both sides, (b) Grind smoothly the surface constituted with the (c) this conductive layer 5 and the conductive material 4, and (d) Rank second, after making this breakthrough 3 for through holes fill up with and harden the hardenability conductive material 9 which gives the cured body which

has conductivity, After forming the surface circuit pattern 2 in the above-mentioned conductive layer 5, the circuit board of this invention can be manufactured by applying hardenability conductive material and forming the electric conduction pattern 7 of uniform thickness so that the connection section of (e) this through hole part and this surface circuit pattern 2 may be covered.

[0054]Before forming the surface circuit pattern 2 in both sides of an insulating substrate, as shown in drawing 5, as a method of forming a conductive pattern beforehand, (a) Form the breakthrough 3 for through holes in the insulating substrate 1 which has the conductive layer 5 to both sides, (b) Grind smoothly the surface constituted with the (c) this conductive layer 5 and the conductive material 4, and (d) Rank second, after making this breakthrough for through holes fill up with and harden the hardenability conductive material 9 which gives the cured body which has conductivity, After applying hardenability conductive material and forming the electric conduction pattern 7 of uniform thickness so that this through hole part and the conductive layer around this through hole may be covered, the circuit board of this invention can be manufactured by forming the surface circuit pattern 2 in the (e) above-mentioned conductive layer 5.

[0055]Also when the layered product of two or more insulating substrates by which the circuit pattern 11 was formed among two or more insulating substrates is used, it can manufacture by the same method as the above. When the breakthrough 3 for through holes is formed in this layered product, are not limited in particular, but the wall of this breakthrough by carrying out SUMIYA removal or etchback processing, The connection stability of the conductive material formed in this breakthrough and the circuit pattern 11 formed between insulating substrates improves, and the reliability of a flow of a through hole part improves.

[0056]In a described method, the formation method of the breakthrough 3 for through holes is used, without limiting the same publicly known means in particular as manufacture of the usual circuit boards, such as drilling processing, punching work, and laser processing.

[0057]Restoration of the hardenability conductive material to the breakthrough 3 for through holes formed in the above-mentioned insulating substrate 1, This hardenability conductive material 9 fills the whole space of the breakthrough for through holes, and it is more desirable than the surface of the surface circuit pattern 2 or the conductive layer 5 to specifically be preferably filled up 0.1 mm or more a little, to such an extent that it projects 0.1 mm - 2 mm. If the typical method of being filled up with hardenability conductive material is illustrated, means, such as a method with which it is filled up by the method of performing spreading of 1 time or multiple times by print processes, the method of pressing fit by the squeegee of a rear surface couple from the rear surface both-sides side of an insulating substrate, the roll coater, or a curtain coating machine, will be used suitably.

[0058]In order that the electrical conducting material which originally contains hardenability conductive material in hardenability conductive material by the cure shrinkage at the time of binder hardening when being filled up with the above-mentioned hardenability conductive material 9 may contact, conductivity is presented and contraction certainly follows at the time of hardening. Therefore, when filling up the breakthrough 3 for through holes with this hardenability conductive material 9, it is preferred to be taken into consideration and filled up with contraction so that the cured body surface of this hardenability conductive material may not be dented from the above-mentioned circuit pattern 2 after hardening.

[0059]What is necessary is for hardening of the hardenability conductive material 9 with which the above-mentioned breakthrough 3 for through holes was filled up to choose what suitable suitably, and just to stiffen it from publicly known curing methods, such as a hot blast stove, an infrared furnace, a far-infrared furnace, an ultraviolet curing furnace, and electron beam curing oven.

[0060]Although hardening of the hardenability conductive material 9 with which the above-mentioned breakthrough 3 for through holes was filled up is generally immediately carried out after restoration again, it is also possible to carry out simultaneously at the time of the electric conduction pattern 7 formation which is a post process.

[0061]If the method of making substantially conductive material 4 with which the breakthrough 3 for through holes was filled up the surface circuit pattern 2 of the above-mentioned insulating substrate 1 or the conductive layer 5 with the same flat surface is illustrated concretely, After filling up the breakthrough 3 for through holes with the above-mentioned hardenability conductive material 9, the method of grinding smoothly the portion which stiffened and the cured body (conductive material) of this hardenability conductive material projected from this surface circuit pattern 2 or the conductive layer 5 is preferred. The method by which the above-mentioned conductive material 4 is used for polish of the usual circuit boards, such as slurry polish, buffing, scrub polish, and belt polishing, as a method of grinding smoothly the portion projected from this surface circuit pattern or the conductive layer 5 is used suitably.

[0062]Although not shown in a figure, when grinding the surface of the conductive material 4 smoothly, in order to protect the surface circuit pattern 2, in the process of (c) of drawing 3, it is possible to also make the overcoat layer which becomes this surface circuit pattern 2 from said resist form.
[0063]The method in particular of forming the circuit pattern 2 from the conductive layer 5 of the insulating substrate 1 is not limited, but a publicly known method is especially adopted without restriction.
[0064]If a general formation method is illustrated, the way etching resist performs etching on the surface of this conductive layer 5 of the insulating substrate 1 that has the conductive layer 5 to both sides after forming an etching pattern for example, is common. Especially, the etching resist used here is used without restriction, and a dry film, resist ink, etc. should just use it by the fine degree of a pattern, choosing it suitably. The etching resist pattern should just adopt a positive pattern or a negative pattern suitably with an etching method. For example, what is necessary is just to adopt a negative pattern in the etching method represented with the etching method represented by tenting by the solder exfoliating method and the SES method in a positive pattern.
[0065]When forming a circuit pattern after grinding smoothly the surface which is shown in drawing 4 and drawing 5 and which is constituted with the conductive layer 5 and the conductive material 4 without forming a circuit pattern beforehand, If it forms by the ED method using an electrodeposition photoresist film, in order to form a resist film electrically, adverse effects, such as garbage, are not received but a highly precise and reliable circuit pattern is acquired.
[0066]Since the breakthrough 3 for through holes is filled up with the conductive material 4 if the electrodeposition photoresist film of a negative mold is used especially, it is not necessary to expose the inside of this breakthrough for through holes, and the through hole of a byway of 0.3 mm or less can be formed with sufficient reliability.
[0067]As a method of applying hardenability conductive material and forming the electric conduction pattern 7 of uniform thickness so that a connection section with said through hole part, the surface circuit pattern 2, or the conductive layer 5 of this through hole part circumference may be covered, the manufacturing method of the electric conduction pattern by publicly known printing is adopted suitably. After applying hardenability conductive material to a required part using a dispenser, specifically, the method of hardening, the method of hardening, after carrying out **** print coating for screen printers, etc. are mentioned. Since it is stabilized and these parts are carried when carrying out direct continuation of the surface mounted device on the conductive pattern 7 on the above mentioned above-mentioned through hole part, When applying this hardenability conductive material and forming the electric conduction pattern of uniform thickness in up to circuit patterns other than on [in which a surface mounted device is carried directly] a through hole part, the same formation method as the above is adopted, and it is usually carried out simultaneously.
[0068]A connection section with the above-mentioned through hole part, the surface circuit pattern 2, or the conductive layer 5 of this through hole part circumference hardening of wrap hardenability conductive material, What is necessary is to choose suitably a thing suitable for hardening of hardenability conductive material, and just to stiffen it from publicly known curing methods, such as a hot blast stove, an infrared furnace, a far-infrared furnace, an ultraviolet curing furnace, and electron beam curing oven, as well as the curing method of the hardenability conductive material 9 with which the above-mentioned breakthrough 3 for through holes was filled up.
[0069]Since it is formed in this invention so that the conductive material 4, the surface circuit pattern 2, or the conductive layer 5 with which the breakthrough 3 for through holes was filled up may make the same flat surface substantially as mentioned above, For example, when applying hardenability conductive material to the above-mentioned connection section using a screen printer, there is no generating of the blot at the time of printing, as a result it excels in workability and it becomes possible to apply hardenability conductive material uniformly moreover.
[0070]The thickness of the electric conduction pattern 7 formed in a through hole part and the connection section of the surface circuit pattern 2 is uniform, and thin. Therefore, conductive material was formed in the surface circuit pattern part and the lobe in 2 steps by a means by which it is filled up so that it may project so that the above mentioned conventional conductive material might be covered around the breakthrough for through holes and it might hang, but according to this invention, formation of the solder regist layer became possible [carrying out with sufficient accuracy at once].
[0071]After grinding smoothly the surface which is shown in drawing 5 and which is constituted with the conductive layer 5 and the conductive material 4 without forming the surface circuit pattern 2 beforehand, When the electric conduction pattern 7 is formed and the surface circuit pattern 2 is formed, the surface of the

conductive material 4 with which the breakthrough 3 for through holes was filled up Etching resist, Since it is not put to alkaline solutions, such as release liquid of this etching resist, and the pickling solution for surface treatments and neither the surface of this conductive material 4 nor the connection interface of this conductive material and the land 8 is polluted, the good through hole of reliability can be formed.
[0072]In the method of grinding smoothly the surface constituted with the surface circuit pattern 2 or the hardenability conductive material 9, and the conductive material 4 in this invention, and forming the electric conduction pattern 7, After grinding one side smoothly and forming the electric conduction pattern 7, another field may be ground and the electric conduction pattern 7 may be formed.
[0073]Therefore, according to the method of this invention, reliability is good and the electrical link of a through hole part and a circuit pattern can be performed certainly.
[0074]
[Effect]In the above explanation, so that clearly the circuit board of this invention, Without performing electroless plating and electroplating, moreover, soldering paste printing at the time of mounting of a surface mounted device can carry out with sufficient accuracy highly [the thickness of the electric conduction pattern formed in the connection section of a through hole part and a surface circuit pattern is uniform, and / the conduction reliability of a through hole], and the connection reliability of a surface mounted device is high.
[0075]Since the surface of the hardened hardenability conductive material with which the breakthrough for through holes was filled up has the same flat surface substantially with a circuit pattern according to the manufacturing method of this invention, Formation of the electric conduction pattern by the hardenability conductive material of the connection section of a through hole part and a circuit pattern which is a next process can carry out with sufficient accuracy uniformly.
[0076]Therefore, compared with the circuit board which performed conventional electroless plating and electroplating, it is high yield and the circuit board of this invention is the circuit board with high packaging density and wiring density.
[0077]
[Example]Hereafter, in order to explain this invention concretely, an example is shown, but this invention is not limited to these examples.
[0078]The copper paste of the following presentations was used as the hardenability conductive material 9 with which the breakthrough 3 for example 1 through holes is filled up. Namely, a weight per epoxy equivalent receives bisphenol-A-diglycidyl-ether and this bisphenol-A-diglycidyl-ether 100 weight section which is 173g/Eq as a binder component, Novolac type phenol resin as the decyl glycidyl ether of 35 weight sections, and a hardening agent 39 weight sections, 360 weight sections of arborescence copper powder with a mean particle diameter of 10.5 micrometers was added to binder 100 weight section as copper powder, further, 2.8 weight-section ********** was kneaded for 2-ethyl-4-methylimidazole for 45 minutes with 3 rolls to binder 100 weight section, and copper paste was prepared.
[0079]As hardenability conductive material of the electric conduction pattern 7 formed as covers the connection section of a through hole part and a circuit pattern, the main ingredients of the binder used Tatsuta Electric Wire & Cable [Co., Ltd.] Co., Ltd. copper metallurgy paste NF-2000 which is resol type phenol resin.
[0080]Copper paste NF2000 by Tatsuta Electric Wire & Cable Co., Ltd. which uses resol type phenol resin of "copper paste A" and the latter as the main ingredients for the copper paste which uses the former epoxy resin as the main ingredients of a binder hereafter is indicated as "copper paste B."
[0081]The circuit board was manufactured according to the process shown in drawing 3. Namely, a glass epoxy board with a thickness of 1.2 mm which has the conductive layer 5 which consists of copper foil is used for both sides as the (a) insulating substrate 1, The breakthrough 3 for through holes 0.6 mm in diameter by drilling 100 ******, The surface circuit pattern 2 containing 50 micrometers in width, the line of 50 micrometers of intervals, and a land is formed in both sides of this insulating substrate, (b) To this breakthrough for through holes, as the hardenability conductive material 9, copper paste A so that it may project 0.25 mm from the above-mentioned surface circuit pattern, After being filled up with screen printing and making it harden on the conditions for 180 ** to 60 minutes with air oven for 50 **-30 minutes, (c) Use the buff of No. 200, and the buff of No. 360 for the surface constituted with this surface circuit pattern and hardenability conductive material one by one, The whole substantial surface of (d) this through hole part after forming the through hole part with which it ground smoothly and the conductive material 4 was filled up, Copper paste B is applied for a peripheral area with a width of 0.1 mm of the surface circuit pattern 2 linked to this through hole with screen printing as wrap hardenability conductive material, It hardened on the conditions for 160 ** to 30 minutes with air oven, the electric conduction pattern 7 with an average thickness of 30 micrometers (**about 10% of variation) was formed, and

100 double-sided circuit boards were obtained.
[0082]The short circuit and open circuit of the circuit pattern did not generate the obtained circuit board, but the yield was 100%. When the resistance of the through hole was measured about this circuit board between the electric conduction patterns 7 formed in the rear surface of the circuit board, they were 15mohm / hole on the average. After putting this circuit board by the high-humidity/temperature condition of 60 **-90%RH for 1000 hours, when through hole resistance was measured again, they were 17mohm / hole on the average. The above-mentioned circuit board was also able to have little unevenness of a substrate face, could also perform soldering paste printing at the time of mounting of a surface mounted device good, and was able to connect the surface mounted device with sufficient reliability.
[0083]The circuit board was manufactured according to the process shown in example 2 drawing 4. To namely, the insulating substrate 1 of a glass epoxy board with a thickness of 1.2 mm which has the conductive layer 5 which becomes (a) both sides from copper foil. The breakthrough 3 for through holes 0.5 mm in diameter by drilling 100 ******, (b) Fill up this breakthrough 3 for through holes with copper paste A with screen printing as the hardenability conductive material 9, After making it harden on the conditions for 180 ** to 60 minutes with air oven for 50 **-30 minutes, the buff of No. 200 and the buff of No. 360 are used for the surface constituted with (c) this conductive layer and hardenability conductive material one by one, After forming the through hole part with which it ground smoothly and the conductive material 4 was filled up, (d) The whole substantial surface of (e) this through hole part after ranking second, using etching resist for this conductive layer 5 and forming in both sides the surface circuit pattern 2 containing 50 micrometers in width, the line of 50 micrometers of intervals, and a land, Copper paste B is applied for a peripheral area with a width of 0.1 mm of the surface circuit pattern 2 linked to this through hole with screen printing as wrap hardenability conductive material, Copper paste B was hardened on air oven 160 **-30 minute conditions, the electric conduction pattern 7 with an average thickness of 25 micrometers (**about 10% of variation) was formed, and 100 double-sided circuit boards were obtained.
[0084]The short circuit and open circuit of the circuit pattern did not generate the obtained circuit board, but the yield was 100%. When the resistance of the through hole was measured about this circuit board between the electric conduction patterns 7 formed in the rear surface of the circuit board, they were 19mohm / hole on the average. After putting this circuit board by the high-humidity/temperature condition of 60 **-90%RH for 1000 hours, when through hole resistance was measured again, they were 22mohm / hole on the average. The above-mentioned circuit board was also able to have little unevenness of a substrate face, could also perform soldering paste printing at the time of mounting of a surface mounted device good, and was able to connect the surface mounted device with sufficient reliability.
[0085]The circuit board was manufactured according to the process shown in example 3 drawing 5. To namely, the insulating substrate 1 of a glass epoxy board with a thickness of 1.2 mm which has the conductive layer 5 which becomes (a) both sides from copper foil. The breakthrough 3 for through holes 0.5 mm in diameter by drilling 100 ******, (b) Fill up this breakthrough 3 for through holes with copper paste A with screen printing as the hardenability conductive material 9, After making it harden on the conditions for 180 ** to 60 minutes with air oven for 50 **-30 minutes, the buff of No. 200 and the buff of No. 360 are used for the surface constituted with (c) this conductive layer and hardenability conductive material one by one, The whole substantial surface of (d) this through hole part after forming the through hole part with which it ground smoothly and the conductive material 4 was filled up, Copper paste B is applied for a peripheral area with a width of 0.1 mm of the surface circuit pattern 2 linked to this through hole with screen printing as wrap hardenability conductive material, Harden copper paste B on air oven 160 **30 minute conditions, and the electric conduction pattern 7 with an average thickness of 25 micrometers (**about 10% of variation) is formed, (e) It ranked second, etching resist was used for this conductive layer 5, the surface circuit pattern 2 containing 50 micrometers in width, the line of 50 micrometers of intervals, and a land was formed in both sides, and 100 double-sided circuit boards were obtained.
[0086]The short circuit and open circuit of the circuit pattern did not generate the obtained circuit board, but the yield was 100%. When the resistance of the through hole was measured about this circuit board between the electric conduction patterns 7 formed in the rear surface of the circuit board, they were 18mohm / hole on the average. After putting this circuit board by the high-humidity/temperature condition of 60 **-90%RH for 1000 hours, when through hole resistance was measured again, they were 19mohm / hole on the average. The above-mentioned circuit board was also able to have little unevenness of a substrate face, could also perform soldering paste printing at the time of mounting of a surface mounted device good, and was able to connect the surface mounted device with sufficient reliability.

[0087]According to the process shown in example 4 drawing 4, the circuit board was manufactured and, finally nickel and gilding were given. To namely, the insulating substrate 1 of a glass epoxy board with a thickness of 1.2 mm which has the conductive layer 5 which becomes (a) both sides from copper foil. The breakthrough 3 for through holes 0.5 mm in diameter by drilling 100 ******, (b) Fill up this breakthrough 3 for through holes with copper paste A with screen printing as the hardenability conductive material 9, After making it harden on the conditions for 180 ** to 60 minutes with air oven for 50 **-30 minutes, the buff of No. 200 and the buff of No. 360 are used for the surface constituted with (c) this conductive layer and hardenability conductive material one by one, After forming the through hole part with which it ground smoothly and the conductive material 4 was filled up, (d) The whole substantial surface of (e) this through hole part after ranking second, using etching resist for this conductive layer 5 and forming in both sides the surface circuit pattern 2 containing 50 micrometers in width, the line of 50 micrometers of intervals, and a land, Copper paste B is applied with screen printing as hardenability conductive material so that the pad section which covers a peripheral area with a width of 0.1 mm of the surface circuit pattern 2 linked to this through hole, and carries a surface mounted device may be covered, After hardening copper paste B on air oven 160 **-30 minute conditions and forming the electric conduction pattern 7 with an average thickness of 25 micrometers (**about 10% of variation), 4 micrometers of nickel plating and 0.2 micrometer of gilding gave on this surface circuit pattern and this electric conduction pattern, and 100 double-sided circuit boards were obtained.

[0088]The short circuit and open circuit of the circuit pattern did not generate the obtained circuit board, but the yield was 100%. When the resistance of the through hole was measured about this circuit board between the electric conduction patterns 7 formed in the rear surface of the circuit board, they were 19mohm / hole on the average. After putting this circuit board by the high-humidity/temperature condition of 60 **-90%RH for 1000 hours, when through hole resistance was measured again, they were 20mohm / hole on the average. The above-mentioned circuit board was also able to have little unevenness of a substrate face, could also perform soldering paste printing at the time of mounting of a surface mounted device good, and was able to connect the surface mounted device with sufficient reliability. The surface mounted device was able to be connected with sufficient reliability on the electric conduction pattern.

[0089]Using the layered product of example 5 insulating substrate, according to the process shown in drawing 4, the circuit board was manufactured and, finally nickel and gilding were given. Namely, it has a circuit pattern which consists of a layered product of a (a)3 sheet insulating substrate, and consists of copper foil between insulating substrates, To the layered product of the insulating substrate of 1.2-mm-thick glass epoxy which has the conductive layer 5 which becomes both the surfaces of this layered product from copper foil. The breakthrough 3 for through holes 0.5 mm in diameter by drilling 100 ******, (b) Fill up this breakthrough 3 for through holes with copper paste A with screen printing as the hardenability conductive material 9, After making it harden on the conditions for 180 ** to 60 minutes with air oven for 50 **-30 minutes, the buff of No. 200 and the buff of No. 360 are used for the surface constituted with (c) this conductive layer and hardenability conductive material one by one, After forming the through hole part with which it ground smoothly and the conductive material 4 was filled up, Rank second, use etching resist for this conductive layer 5, and to both sides (d) 50 micrometers in width. After forming the front surface circuit pattern 2 containing the line of 50 micrometers of intervals, and a land, so that the connection section of (e) this through hole part and the surface circuit pattern 2 may be covered, And apply copper paste B with screen printing as hardenability conductive material so that the pad section which carries a surface mounted device may be covered, and copper paste B is hardened on air oven 160 **-30 minute conditions, After forming the electric conduction pattern 7 with an average thickness of 25 micrometers (**about 10% of variation), 4 micrometers of nickel plating and 0.2 micrometer of gilding gave on this circuit pattern and this electric conduction pattern, and 100 multilayered circuit boards were obtained.

[0090]The short circuit and open circuit of the circuit pattern did not generate the obtained circuit board, but the yield was 100%. When the resistance of the through hole was measured about this circuit board between the electric conduction patterns 7 formed in the rear surface of the circuit board, they were 19mohm / hole on the average. When the resistance of the through hole of inner layers was measured, they were 22mohm / hole. After putting this circuit board by the high-humidity/temperature condition of 60 **-90%RH for 1000 hours, when the through hole resistance of the conductive pattern formed in the circuit board rear surface was measured again and the through hole resistance of 20mohm / hole, and inner layers was again measured on the average, they were 22mohm / hole on the average. The above-mentioned circuit board was also able to have little unevenness of a substrate face, could also perform soldering paste printing at the time of mounting of a surface mounted device good, and was able to connect the surface mounted device with sufficient reliability. The surface mounted

device was able to be connected with sufficient reliability on the electric conduction pattern.
[0091]In comparative example 1 Example 1, the circuit board was manufactured by the process of (a) – (b). Since a surface mounted device was mounted in the obtained circuit board, soldering paste was printed with screen printing to this circuit board, but most soldering paste was not printed by this circuit board, and was not able to mount parts. When the resistance of the through hole was measured by the rear surface of the obtained circuit board, they were 17mohm / hole on the average. After putting this circuit board by the high-humidity/temperature condition of 60 **-90%RH for 1000 hours, when through hole resistance was measured again, it became 98mohm / hole on the average, and the rise of resistance was remarkable.
[0092]After forming a through hole part by the process of (a) – (c) in comparative example 2 Example 3, The plating layer common to a through hole part and conductive layer top was formed, subsequently to this plating layer and this conductive layer 5 etching resist was used, the surface circuit pattern 2 containing 50 micrometers in width, the line of 50 micrometers of intervals, and a land was formed in both sides, and 100 double-sided circuit boards were obtained. The short circuit and open circuit of the circuit pattern generated the obtained circuit board, and the yield was 27%.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a sectional view showing the typical mode of the circuit board of this invention.
[Drawing 2]It is a sectional view showing the typical mode of the circuit board of this invention.
[Drawing 3]It is typical manufacturing method **** process drawing of the circuit board of this invention.
[Drawing 4]It is typical manufacturing method **** process drawing of the circuit board of this invention.
[Drawing 5]It is typical manufacturing method **** process drawing of the circuit board of this invention.
[Drawing 6]It is a flat surface which shows the typical mode of the electric conduction pattern in the circuit board of this invention.
[Drawing 7]It is a flat surface which shows the typical mode of the electric conduction pattern in the circuit board of this invention.
[Drawing 8]It is a flat surface which shows the typical mode of the electric conduction pattern in the circuit board of this invention.
[Description of Notations]
1 Insulating substrate
2 Surface circuit pattern
3 The breakthrough for through holes
4 Conductive material
5 Conductive layer
6 Overcoat layer
7 Electric conduction pattern
8 Land
9 Hardenability conductive material
11 The circuit pattern formed between insulating substrates
12 Nickel and a gilding layer
13 Pad section

[Translation done.]

* NOTICES *

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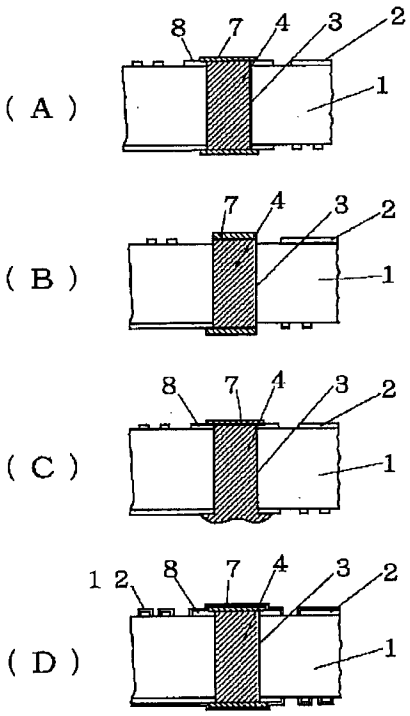
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

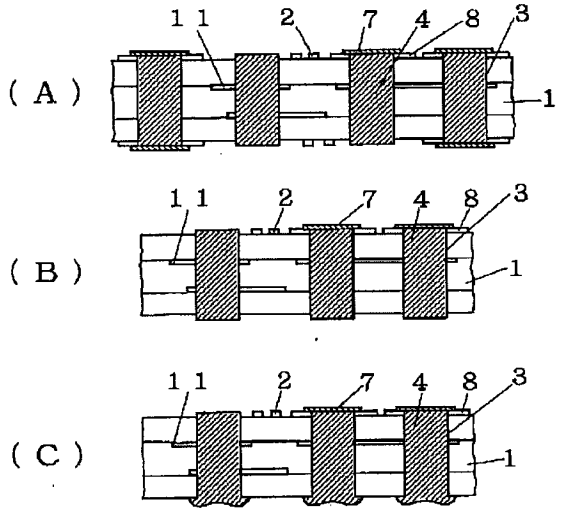
[Drawing 1]

図 1



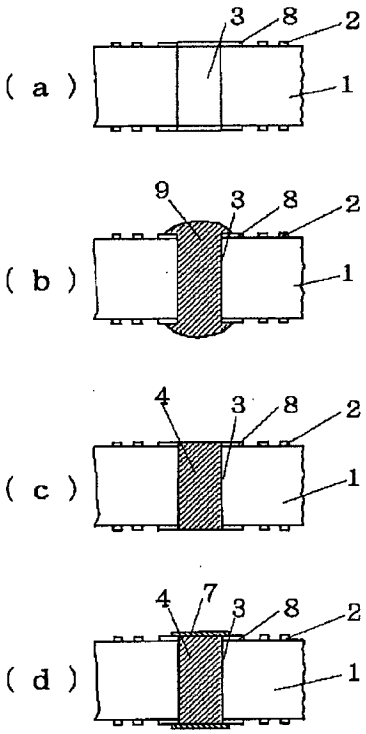
[Drawing 2]

図 2



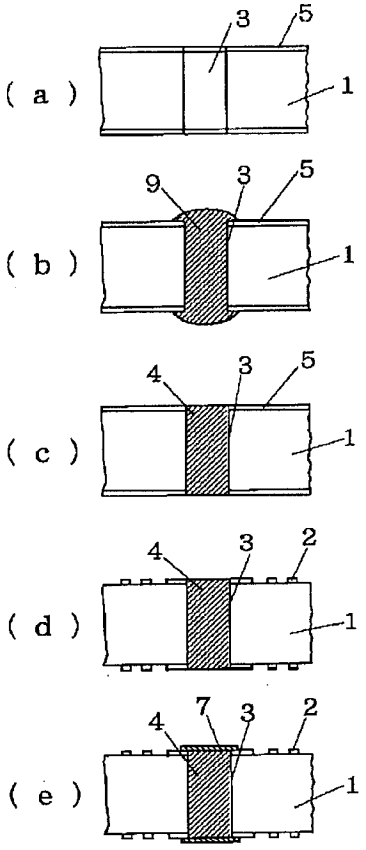
[Drawing 3]

図３



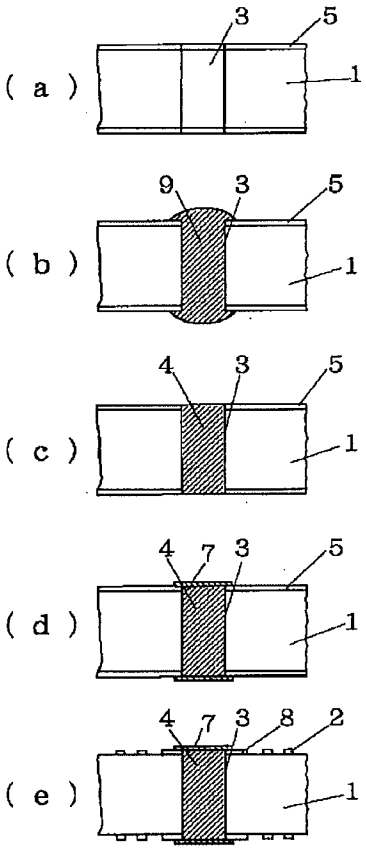
[Drawing 4]

図４



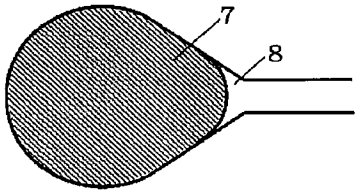
[Drawing 5]

図 5



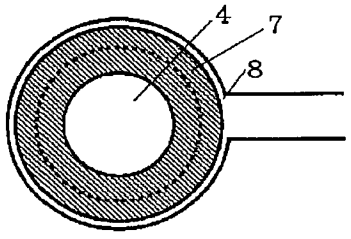
[Drawing 6]

図 6



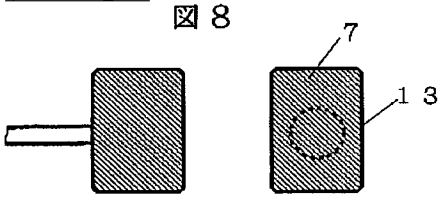
[Drawing 7]

図 7



[Drawing 8]

図 8



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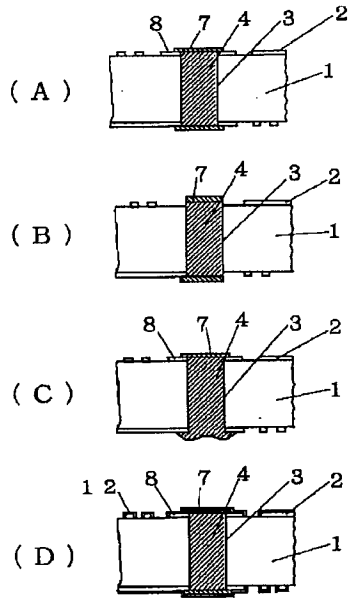
(54)【発明の名称】　回路基板

(57)【要約】
【課題】スルーホールの導通信頼性が高く、且つ表面実装部品の実装時の半田ペースト印刷が精度よく行え、表面実装部品の接続信頼性が高い回路基板を得る。
【解決手段】両面に回路パターンが形成された絶縁基板よりなり、該絶縁基板の両面に存在する回路パターン間の電気的な接続の必要な箇所に、該絶縁基板を貫通するスルーホール用貫通孔が設けられ、該スルーホール用貫通孔に導電物質が充填されて該回路パターンと実質的に同一平面を有するスルーホール部が形成され、且つ、該スルーホール部と回路パターンとの接続部分を覆う均一な厚みの、硬化性導電物質、例えば、バインダーの主成分がレゾール型のフェノール樹脂である硬化性導電物質の硬化体よりなる導電パターンが形成された回路基板。

図１



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【特許請求の範囲】

【請求項１】両面に回路パターンが形成された絶縁基板よりなり、該絶縁基板の両面に存在する回路パターン間の電気的な接続の必要な箇所に、該絶縁基板を貫通するスルーホール用貫通孔が設けられ、該スルーホール用貫通孔に導電物質が充填されて該回路パターンと実質的に同一平面を有するスルーホール部が形成され、且つ、該スルーホール部と回路パターンとの接続部分を覆う均一な厚みの、硬化性導電物質の硬化体よりなる導電パターンが形成されたことを特徴とする回路基板。

【請求項２】複数の絶縁基板の積層体よりなる回路基板であって、該積層体の少なくとも一表面と複数の絶縁基板の間には回路パターンが形成されてなり、該積層体の表面に形成された回路パターンと絶縁基板の間に形成された回路パターンとの間、或いは該積層体の両表面に回路パターンが形成されている場合には、両表面回路パターン同士の間で電気的な接続が必要な箇所に、該積層体を貫通するスルーホール用貫通孔が設けられ、該スルーホール用貫通孔に導電物質が充填されて該積層体の表面に形成された回路パターンと実質的に同一表面を有するスルーホール部が形成され、且つ、該スルーホール部と表面に形成された回路パターンとの接続部分を覆う均一な厚みの、硬化性導電物質の硬化体よりなる導電パターンが形成されたことを特徴とする回路基板。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、新規な回路基板に関する。詳しくは両面に回路パターンを有する回路基板、或いは積層体の少なくとも一表面と複数の絶縁基板の間に回路パターンを有する回路基板において、該回路パターン間の導通を硬化性導電物質の硬化体よりなるスルーホール部を設けて行う場合に、信頼性よく、且つ簡便に行うことが可能な回路基板に関する。

【０００２】

【従来の技術】一般に、両面に回路パターンを形成した回路基板における表裏の回路パターンの導通は、スルーホール部を介して行われる。従来、かかるスルーホール部を有する回路基板の製造方法としては、（イ）両面に導電層を有する絶縁基板にドリリングにより貫通孔を形成し、該貫通孔に化学鍍金・電気鍍金を施した後、該導電層をエッチングすることにより回路パターンを形成する方法、或いは、（ロ）両面に導電層を有する絶縁基板に、ドリリングまたはパンチングによりスルーホール用の貫通孔を形成した後、該導電層をエッチングして回路パターンを形成し、次いで、該貫通孔に銅ペースト・銀ペーストに代表される硬化性導電物質をスクリーン印刷法或いはピン挿入法により充填、硬化して導電物質が充填されたスルーホールを形成する方法などが一般に知られている。

【０００３】特に、上記の（イ）の回路基板の製造方法

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は、古くから工業的に行われているものであり、現在の主流を占めている。

【０００４】

【発明が解決しようとする課題】しかしながら、上記（イ）の回路基板の製造方法において、スルーホール部の信頼性を向上させるためには鍍金を２度以上にわたって行う必要があり、コストの面では必ずしも有利な方法とは言えない。また、回路基板全面に電気鍍金が行われるため、導電層の厚みが不均一となり、パターン形成のためのエッチングの際、バラツキが生じるおそれがある。そのため、ファインパターンを有する回路基板への対応が困難であるという欠点を有している。

【０００５】また、上記（ロ）の回路基板の製造方法は、スルーホール用貫通孔内への化学鍍金・電気鍍金が必要ないため、製造工程が短い等の特徴を有していることから近年需要が増大しつつあるが、導電物質を充填して得られたスルーホール部は、これに接続する配線パターンとの電気的な接続の信頼性を確保するため、スルーホール用貫通孔の周囲にまで導電物質を覆い被せ、回路基板の平面よりも突出するように充填する必要がある。その結果、得られた回路基板は、突出した導電物質による基板表面の凹凸が表面実装部品の実装時における半田ペースト印刷の障害となり、表面実装部品を信頼性良く接続する妨げとなっている。

【０００６】一方、本発明者らは、上記（ロ）の回路基板を改良すべく、スルーホール用貫通孔に硬化性導電物質を突出するように充填・硬化した後、導電物質よりなる突出部を絶縁基板の両面に設けられた導電層と同一表面を形成するように研削してスルーホール部を形成し、ついで、導電層のエッチングを行い回路パターンを形成した回路基板を提供した。また、この場合、スルーホール部の導電物質と導電層の上に共通した鍍金層を形成し、その後、導電層のエッチングを行って回路パターンを形成させ、該回路パターンと該スルーホール部との電気的接続の信頼性を向上する手段についても提案した。

【０００７】上記方法によって得られた回路基板は、基板表面の凹凸も少なく、表面実装部品の実装時における半田ペースト印刷も良好に行え、表面実装部品を信頼性よく接続することが可能であるが、導電層上に更に鍍金層を形成する必要があり、前記（イ）の回路基板までではないが、ファインパターンの形成において若干の問題を有していた。

【０００８】

【課題を解決するための手段】本発明者らは、スルーホール部を有する回路基板における上記の問題を解決すべく鋭意研究を重ねた。

【０００９】その結果、スルーホール用貫通孔に導電性物質が充填されて表面の回路パターンと同一平面を有するスルーホール部が形成され、該スルーホール部と表面の回路パターンとの接続部分を覆うように硬化性導電物

質による均一な厚みの導電パターンが形成された回路基板が、該スルーホール部とこれに接続する表面の回路パターンとの電気的接続の信頼性の向上を極めて効果的に図ることができること、また、該導電パターンの形成は印刷等の簡易な方法により行うことができ、且つ鍍金による手段に比べて導電層の厚みに影響を与えないため、回路パターンの形成におけるエッチングにも悪影響を与えることがなく、高度なファインパターンにも十分に対応し得ることを見いだし、本発明を完成するに至った。

【００１０】即ち、本発明は、両面に回路パターンが形成された絶縁基板よりなり、該絶縁基板の両面に存在する回路パターン間の電気的な接続が必要な箇所に、該絶縁基板を貫通するスルーホール用貫通孔が設けられ、該スルーホール用貫通孔に導電物質が充填されて該回路パターンと実質的に同一平面を有するスルーホール部が形成され、且つ、該スルーホール部と回路パターンとの接続部分を覆う均一な厚みの、硬化性導電物質の硬化体よりなる導電パターンが形成されたことを特徴とする回路基板である。

【００１１】

【発明の実施の形態】以下、本発明を添付図面に従って更に詳細に説明するが、本発明はこれら添付図面になんら限定されるものではない。本発明の回路基板の代表的な態様を図１および図２に示した。

【００１２】図１において、絶縁基板１は特に制限されず、公知の材質、構造を有するものが制限なく使用することができる。例えば、紙基材－フェノール樹脂積層基板、紙基材－エポキシ樹脂積層基板、紙基材－ポリエステル樹脂積層基板、ガラス基材－エポキシ樹脂積層基板、紙基材－テフロン樹脂積層基板、ガラス基材－ポリイミド樹脂積層基板、ガラス基材－ＢＴ（ビスマレイミド－トリアジン）レジン樹脂積層基板、コンポジット樹脂基板等の合成樹脂基板や、ポリイミド樹脂、ポリエステル樹脂等のフレキシブル基板や、アルミニウム、鉄、ステンレス等の金属をエポキシ樹脂等で覆って絶縁処理した金属系絶縁基板、あるいはセラミックス基板等が挙げられる。

【００１３】本発明の回路基板において複数の絶縁基板の積層体を用いる場合、該積層体の形成方法は、特に限定されない。通常、必要に応じて回路パターンが施された絶縁基板を積層する方法が採用され、一般的には、絶縁基板間にプリプレグを挟み積層されるピンラミネート方式およびマスラミネート方式が好適に用いられる。また、絶縁基板の層数は、パターンの必要に応じて決定される。回路パターンは、該積層体の両表面或いは一表面と、複数の絶縁基板の間に形成される。

【００１４】本発明の回路基板は、絶縁基板が１枚の場合には、その両面に回路パターンを有しており、絶縁基板が複数枚の積層体の場合には、少なくとも一表面と複数の絶縁基板の間に回路パターンを有する。上記の回路

パターンとしては、配線パターン、ランド部、パッド部等の公知のパターンが必要に応じて形成される。

【００１５】形成される回路パターンの材質は特に制限されないが、代表的な材質を例示すれば、銅、ニッケル等が挙げられる。また、上記回路パターンの厚み等についても特に制限されないが、一般には、５～７０μｍの厚みが適当である。

【００１６】本発明において、スルーホール用貫通孔３は、絶縁基板が１枚の場合にはその両面に形成された回路パターン間の電気的な接続の必要な箇所に、また、絶縁基板が複数の積層体の場合には、積層体の表面に形成された回路パターンと絶縁基板の間に形成された回路パターンとの間、または、該積層体の両表面に回路パターンが形成されている場合には、両表面回路パターン同士の間、さらには、該積層体の両表面の回路パターンと絶縁基板の間に形成された回路パターンとの間で電気的な接続の必要な箇所に設けられる。

【００１７】該スルーホール用貫通孔３の径は、特に制限されるのものではなく、任意に設定することができる。本発明において、上記スルーホール用貫通孔の径は、導電物質を充填することが可能な程度の孔径以上、通常０．１ｍｍ以上、好ましくは、０．２ｍｍ～２ｍｍより選択することができる。そして、本発明においては、かかる微少な孔径であっても確実に導通をとることが可能であるため、後記するファインパターンの形成に有効である。本発明において、上記スルーホール用貫通孔３には、導電物質４が充填されて両面或いは少なくとも一表面の回路パターン（以下表面回路パターンと記す）２と実質的に同一平面を有するスルーホール部が形成される。該導電物質４の材質は、スルーホール用貫通孔３に固定されると共に、導電性を有するものであれば特に制限されない。本発明においては、回路基板の製造工程において、スルーホール用貫通孔３への充填の容易さや、生産性の面などから、硬化後に導電性を有する硬化体を与える硬化性導電物質９が好適である。

【００１８】上記硬化性導電物質９としては、金、銀、銅、ニッケル、鉛、カーボン等よりなる粉状の導電材料とエポキシ樹脂、フェノール樹脂等の架橋性の熱硬化性樹脂とを必要により有機溶剤と共に混合してペースト状とした公知の硬化性導電物質を使用することができる。これらの硬化性導電物質の中から、エッチングに使用するエッチング液、例えば、塩化第二鉄エッチング液、塩化第二銅エッチング液、過硫酸アンモニウムエッチング液、過硫酸ナトリウムエッチング液、過硫酸カリウムエッチング液、過酸化水素／硫酸エッチング液、硫酸アンモニウム錯イオンを主成分とするアルカリ性エッチング液等のエッチング液により実質的に溶解されない硬化体を与えるものを選択して使用することが好ましい。

【００１９】また、上記硬化性導電物質９は、良好なスルーホール抵抗を得るために、硬化後の電気抵抗が、１

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×１０$^{-3}$Ω・ｃｍ以下となるように、導電材料の選択、及び使用量を調節することが好ましい。

【００２０】本発明において、スルーホール用貫通孔３に充填された導電物質４と表面回路パターン２とが実質的に同一平面をなすように形成することが、得られる回路基板への表面実装部品の実装時における半田ペースト印刷を良好に行うことができ、表面実装部品を信頼性よく接続するために重要であり、また該スルーホール部と表面回路パターン２との接続部分を覆うように形成される硬化性導電物質の硬化体よりなる導電パターン７を、精度よく且つ高い信頼性で確実に形成するために必要である。

【００２１】本発明において、上記スルーホール部と表面回路パターン２との接続部分は、該接続部分を覆うように硬化性導電物質の硬化体による均一な厚みの導電パターン７が形成され、スルーホール部と表面回路パターンの電気的な接続がなされる。

【００２２】上記導電パターン７でスルーホール部と表面回路パターン２との接続部分を均一な厚みで覆うことにより、簡易な手段で、スルーホール部と表面回路パターン２との電気的接続の信頼性を確実に向上させることが可能となる。かかる手段は、スルーホール部と表面回路パターン２との電気的接続の信頼性を向上させる目的で、前記した従来の導電物質をスルーホール用貫通孔の周囲にまで覆い被せ、回路基板の平面よりも突出するように充填する手段よりも、回路基板の表面が平滑に維持される点で、後工程の精度、部品の実装等において極めて有利である。

【００２３】また、同目的で、スルーホール部と回路パターンとを鍍金層によって覆う手段では、スルーホール部に充填された導電物質の硬化体と鍍金層との、熱膨張係数の差が大きく、部品実装のリフロー時において熱応力が該鍍金層に集中し、場合によっては、スルーホールの導通不良につながるおそれがある。これに対して、本発明は、スルーホール部に充填される導電物質と、スルーホール部と回路パターンを覆う硬化性導電物質として、これらの硬化体の熱膨張係数の近似しているものを使用すれば、リフロー時に発生する熱応力が小さく、高い接続信頼性を得ることができる。更に、エッチングのばらつきの原因である鍍金層を有さないため、回路パターンの形成精度に関して有利である。

【００２４】上記導電パターン７によってスルーホール部と表面回路パターン２との接続部分を覆う態様は、少なくともスルーホール部の周縁と表面回路パターン２とが接触する箇所を覆って導電パターンが存在する態様であればよいが、より好ましくは、スルーホール部の実質的に全表面とスルーホール部に接続する表面回路パターンの辺縁部とを覆う態様が好ましい。かかる回路パターンの辺縁部の幅は回路パターンの回路幅等にもよるが、一般には、信頼性を考慮すれば該スルーホール部との接触境界線から０．０５ｍｍ以上で決定することが好ましい。

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【００２５】また、図１の（Ａ）に示すように、更に、信頼性を向上させるため、スルーホール部に接続する回路パターン２にランド部８を設け、上記導電パターンを該ランド部も含めて覆うように形成することが更に好ましい。該ランド部の大きさはスルーホール部の周からの長さが０．０５ｍｍ以上がよいが、回路基板の配線密度を考慮すると２ｍｍ以下になるように設計することが好適である。勿論、図１の（Ｂ）に示すようにランド部を形成しない態様であっても十分に信頼性を確保することが可能である。

【００２６】上記の導電パターン７によってスルーホール部と表面回路パターン２との接続部分を覆う何れの態様においても、図６に示すように、スルーホール部と該表面回路パターンの接続部分の形状を、いわゆるティアドロップ状に形成することもできる。上記接続部分をティアドロップ状に形成することで、該導電パターン７に覆われる表面回路パターンの面積が増し、特に、図１の（Ｂ）に示すランド部を設けない態様においても、接続部の信頼性をより向上することが可能となる。

【００２７】また、上記図１の（Ａ）のように表面回路パターン２にランド部８を設け、上記導電パターン７を該ランド部８も含めて覆うように形成する態様では、図７に示すように、該導電パターンをスルーホール部の中心部を除いて、ドーナッツ状に形成することもできる。このように導電パターン７をドーナッツ状に形成することで、後記する該導電パターンに使用される硬化性導電物質の使用量を低減することができ、経済的にも有利である。

【００２８】また、本発明において、上記スルーホール部と該表面回路パターン２との接続部分を覆うように形成される導電パターン７は、均一な厚みであることが必要である。即ち、該導電パターンを均一にすることで、安定したスルーホール抵抗値を得ることができ、製造時の歩留まりが向上する。また、該導電パターンが厚みに関して均一性を有することによって、部品の実装等において行う半田ペーストの印刷、オーバーコート層の形成等を精度よく行うことができ、表面実装部品の接続信頼性等が向上することができる。

【００２９】更に、上記導電パターン７を均一な厚みにすることで、該導電パターン上において、表面実装部品が安定な状態で搭載される。よって該導電パターン上に表面実装部品を直接接続することが可能となるため、部品実装密度を向上させることができる。

【００３０】上記導電パターン７の厚みは、特に制限されないが、スルーホールの信頼性および半田ペーストの印刷性を考慮すると５μｍ～１００μｍの厚みが好ましく。また、５～５０μｍの範囲に制御すると部品実装が極めて容易に行えるためさらに好適である。また、該導

電パターン７の厚みのばらつきは、該導電パターン７の形成方法や表面実装部品の接続部の大きさに依存するが、その平均厚みに対して±３０％以下となるように調整することが好ましい。

【００３１】更に、本発明においては、上記スルーホール部と該表面回路パターン２との接続部分を覆うように形成される導電パターン７の材質は、前記スルーホール用貫通孔に充填する導電物質として使用される硬化性導電物質と同材質のものを使用することもできるが、特に、スルーホール用貫通孔に充填する導電物質より耐湿性を備えた硬化体を与える硬化性導電物質を使用することが好ましい。

【００３２】かかる耐湿性を備えた導電パターン７を形成することにより、信頼性、特に耐湿性に優れたスルーホール部を有する回路基板を得ることができる。

【００３３】上記耐湿性の硬化体を与える硬化性導電物質は、公知の硬化性導電物質より選択して使用することができる。例えば、上記耐湿性の硬化体を与える硬化性導電物質に含まれる導電材料としては、特には制限されないが、酸化されにくく、且つ固有抵抗値の低い金、銀、銅等の金属や、抵抗値は若干高いが全く酸化の影響を受けないカーボン等が好適に使用できる。

【００３４】また、上記導電材料の中で、隣接する表面回路パターン２との絶縁信頼性を考慮すれば、マイグレーションの少ない金属を採用することが好ましい。中でも、銅は導電性、酸化防止の作業性、コスト等から考えて、特に好適に用いられる。

【００３５】更に、上記硬化性導電物質に含まれる銅等の金属の酸化を防止するため、バインダー成分として熱硬化時に還元性雰囲気を与えるレゾール型のフェノール樹脂を主として使用したものがより好ましい。

【００３６】上記レゾール型のフェノール樹脂をスルーホール用貫通孔３に充填する硬化性導電物質として用いた場合、該樹脂の熱硬化時に副生成物として発生する水分やホルマリンの影響でスルーホール内にボイドが発生し、スルーホール内に充填された硬化性導電物質の硬化体の導電性の低下、更には該スルーホール近辺の回路の信頼性をも損ねるおそれが有るが、本発明においては、導電パターン７の形成において有効に使用することができる。

【００３７】一方、前記したように、スルーホール用貫通孔３に充填する硬化性導電物質９は、特に限定されないが、バインダー成分として、バインダーの硬化時に副生成物の発生の少ないエポキシ樹脂と硬化剤よりなるエポキシ樹脂系バインダーを用いたものが好ましい。該バインダーを用いた硬化性導電物質は、耐湿性において、前述のレゾール型のフェノール樹脂をバインダーとして主として使用した硬化性導電物質より若干劣るものである。しかしながら、本発明の上記態様によれば、かかる耐湿性に乏しい硬化性導電物質を、導電パターン７の耐湿性により保護することができ信頼性を一層高めることが可能である。

【００３８】尚、上記スルーホール用貫通孔に充填する硬化性導電物質９の材質のうち、金属成分は特に制限はされないが、隣接するスルーホールとの絶縁信頼性を考慮すれば、マイグレーションの少ない金属を採用することが好ましい。中でも、銅は導電性、酸化防止の作業性、コスト等から考えて、特に好適に用いられる。

【００３９】本発明においては、スルーホール用貫通孔３にはバインダーの硬化時に副生成物の発生の少ないエポキシ樹脂系のバインダーを用いた硬化性導電物質９を充填し、スルーホール内部の導電物質４を形成し、且つスルーホール部と表面回路パターン２の接続部分を覆うように形成される硬化性導電物質に、レゾール型のフェノール樹脂をバインダー主成分とし、マイグレーションの少ない銅を金属成分とした耐湿性銅ペーストを用いる態様が最も推奨される。

【００４０】かかる構成でスルーホール部を形成することにより、スルーホール内部に欠陥が存在せず、且つ信頼性の高いスルーホール部を有する回路基板を得ることができる。

【００４１】本発明において他の部分は公知の技術を採用でき、特に制限されない。例えば、回路パターンの接続端子以外の部分は、公知の絶縁樹脂（レジスト）により、オーバーコート層を形成することにより保護しても良いし、該表面回路パターン２の表面に公知の手段により接続端子を除いて形成された絶縁層を介して、銅等の鍍金層よりなる回路パターンを形成することもできる。

【００４２】また、表面実装部品が片面だけに実装される場合は、表面実装部品が実装される面のみを本発明の回路基板の態様にすることもできる。即ち、部品が実装されない面は、従来の導電物質をスルーホール用貫通孔の周囲に覆い被せ、導電物質を回路基板の平面から突出するように充填した状態にし、部品を実装する面のみに本発明の回路基板の態様を採用することもできる。

【００４３】更にまた、上記スルーホール部と表面回路パターン２との接続部分を覆うように形成される導電パターン７の材質に、硬化後に半田がコートできる硬化体或いは通常端子鍍金等に用いられるニッケル・金鍍金を形成することのできる硬化体を与える硬化性導電物質を採用すると、導電パターン７（スルーホール部）上に表面実装部品を直接接続することができるため、更に、部品実装密度を向上することが可能となる。上記様態における該導電パターンの形状は、特に限定されないが、図８に示すように、該導電パターンと表面実装部品の接続の安定性を向上させるため、パッド部のほとんど全てを覆い、パッド部を平坦な形状とすることが表面実装部品の実装の容易さから好ましい。更に、実装部品を搭載する全てのパッド部についても該導電パターンを形成する態様が、表面実装部品がより安定した状態で搭載される

ため、表面実装部品の実装の容易さから、更に好ましい。

【００４４】本発明の回路基板の態様は、特に制限されるものではないが、代表的な態様を図１および図２に示す。

【００４５】図１の（Ａ）に示す様態は、スルーホール部に接続する両面の表面回路パターンにランド部８を設け、導電パターン７を該ランド部も含めて覆うように形成したものである。

【００４６】図１の（Ｂ）に示す様態は、スルーホール部に接続する両面の表面回路パターンにランド部８を設けないで、導電パターン７を形成したものである。

【００４７】図１の（Ｃ）に示す様態は、スルーホール部に接続する両面の表面回路パターンにランド部８を設け、片面のみ導電パターン７を該ランド部も含めて覆うように形成したものである。

【００４８】図１の（Ｄ）に示す様態は、スルーホール部に接続する両面の表面回路パターンにランド部８を設け、導電パターンを該ランド部も含めて覆うように形成し、表面回路パターン部および導電パターン部の上にニッケル・金鍍金層を設けたものである。これにより導電パターンが半田濡れ性の悪い導電性ペーストである場合においても、該導電パターン上に表面実装部品を搭載できる。

【００４９】図２の（Ａ）に示す様態は、３つの絶縁基板の積層体よりなる回路基板であって、該絶縁基板の間および該積層体の両表面に表面回路パターン２が形成された場合のもので、スルーホール部に接続する表面回路パターン２にランド部８を設け、導電パターンを該ランド部も含めて覆うように形成したものである。

【００５０】図２の（Ｂ）および（Ｃ）に示す様態は、３つの絶縁基板の積層体よりなる回路基板であって、該絶縁基板の間および該積層体の一表面に表面回路パターン２が形成された場合のもので、スルーホール部に接続する表面回路パターン２にランド部８を設け、導電パターン７を該ランド部も含めて覆うように形成したものである。

【００５１】本発明の回路基板の製造方法は特に制限されるものではないが、代表的な製造方法を例示すれば、図３、図４及び図５に示す方法が挙げられる。

【００５２】即ち、本発明の回路基板は図３に示すように、（ａ）絶縁基板１の両面に形成された表面回路パターン２間の電気的な接続が必要な箇所にスルーホール用貫通孔３を設け、（ｂ）該スルーホール用貫通孔３に導電性を有する硬化体を与える硬化性導電物質９を充填して硬化させた後、（ｃ）絶縁基板の両面に形成された表面回路パターン２及び導電物質４によって構成される表面を実質的に平滑に研削し、（ｄ）次いで、該スルーホール部と上記表面回路パターン２との接続部分を覆うように硬化性導電物質を塗布して均一な厚みの導電パターン７を形成することによって得ることができる。

【００５３】また、予め絶縁基板の両面に表面回路パターン２を形成しない他の方法として、図４に示すように、（ａ）両面に導電層５を有する絶縁基板１にスルーホール用貫通孔３を設け、（ｂ）該スルーホール用貫通孔３に導電性を有する硬化体を与える硬化性導電物質９を充填して硬化させた後、（ｃ）該導電層５及び導電物質４によって構成される表面を平滑に研削し、（ｄ）次いで、上記導電層５に表面回路パターン２を形成した後、（ｅ）該スルーホール部と該表面回路パターン２との接続部分を覆うように硬化性導電物質を塗布して均一な厚みの導電パターン７を形成することによって本発明の回路基板を製造することができる。

【００５４】さらに、絶縁基板の両面に表面回路パターン２を形成する前に、予め導体パターンを形成する方法として、図５に示すように、（ａ）両面に導電層５を有する絶縁基板１にスルーホール用貫通孔３を設け、（ｂ）該スルーホール用貫通孔に導電性を有する硬化体を与える硬化性導電物質９を充填して硬化させた後、（ｃ）該導電層５及び導電物質４によって構成される表面を平滑に研削し、（ｄ）次いで、該スルーホール部と該スルーホール周辺の導電層を覆うように硬化性導電物質を塗布して均一な厚みの導電パターン７を形成した後、（ｅ）上記導電層５に表面回路パターン２を形成することによって本発明の回路基板を製造することができる。

【００５５】複数の絶縁基板間に回路パターン１１が形成された複数の絶縁基板の積層体を用いた場合も、上記と同様の方法により製造することができる。該積層体にスルーホール用貫通孔３を設けた場合、特に限定されないが、該貫通孔の内壁をスミヤ除去或いはエッチバック処理が実施されることにより、該貫通孔内に形成される導電物質と絶縁基板の間に形成された回路パターン１１との接続安定性が向上し、スルーホール部の導通の信頼性が向上する。

【００５６】上記方法において、スルーホール用貫通孔３の形成方法は、ドリリング加工、パンチング加工、レーザー加工等の通常の回路基板の製造と同様の公知の手段が特に限定されずに用いられる。

【００５７】また、上記絶縁基板１に形成されたスルーホール用貫通孔３への硬化性導電物質の充填は、該硬化性導電物質９がスルーホール用貫通孔の全空間を満たし、且つ表面回路パターン２或いは導電層５の表面より若干、具体的には、０．１ｍｍ以上、好ましくは、０．１ｍｍ～２ｍｍ突出する程度に充填することが望ましい。硬化性導電物質の代表的な充填法を例示すれば、印刷法によって１回或いは複数回の塗布を行う方法、絶縁基板の表裏両面側から表裏一対のスキージで圧入する方法、ロールコーター或いはカーテンコーターによって充填する方法等の手段が好適に用いられる。

【００５８】また、上記硬化性導電物質９の充填に際し、硬化性導電物質は本来、バインダー硬化時の硬化収縮により硬化性導電物質に含有される導電材料が接触するため、導電性を呈するものであり、必ず硬化時には収縮が伴う。従って、スルーホール用貫通孔３に該硬化性導電物質９を充填する場合、硬化後に該硬化性導電物質の硬化体表面が上記回路パターン２より凹むことのないよう、収縮率を勘案して充填することが好ましい。

【００５９】また、上記スルーホール用貫通孔３に充填された硬化性導電物質９の硬化は、熱風炉、赤外線炉、遠赤外線炉、紫外線硬化炉、電子線硬化炉等の公知の硬化方法より、適するものを適宜選んで硬化させれば良い。

【００６０】更にまた、上記スルーホール用貫通孔３に充填された硬化性導電物質９の硬化は、一般的には充填後すぐ実施するが、後工程である導電パターン７形成時に同時に行うことも可能である。

【００６１】スルーホール用貫通孔３に充填した導電物質４を、上記絶縁基板１の表面回路パターン２或いは導電層５と実質的に同一平面とする方法を具体的に例示すれば、上記硬化性導電物質９をスルーホール用貫通孔３に充填した後、硬化させ、該硬化性導電物質の硬化体（導電物質）が該表面回路パターン２或いは導電層５より突出した部分を平滑に研削する方法が好適である。上記導電物質４が該表面回路パターン或いは導電層５より突出した部分を平滑に研削する方法としては、スラリー研磨、バフ研磨、スクラブ研磨、ベルト研磨等の通常の回路基板の研磨に用いられる方法が好適に用いられる。

【００６２】尚、図には示されていないが、図３の（ｃ）の工程において、導電物質４の表面を平滑に研削する際、表面回路パターン２を保護するために該表面回路パターン２に前記レジストよりなるオーバーコート層を形成させることも可能である。

【００６３】また、絶縁基板１の導電層５から回路パターン２を形成する方法は特に限定されず、公知の方法が特に制限なく採用される。

【００６４】一般的な形成方法を例示すれば、例えば、両面に導電層５を有する絶縁基板１の該導電層５の表面に、エッチングレジストによりエッチングパターンを形成後、エッチングを行う方法が一般的である。ここで用いられるエッチングレジストはドライフィルム、レジストインク等が特に制限なく使用され、パターンのファイン度によって適宜選択して使用すれば良い。また、エッチングレジストパターンはエッチング法によってポジパターン或いはネガパターンを適宜採用すれば良い。例えば、テンティング法に代表されるエッチング法ではポジパターンを、半田剥離法、ＳＥＳ法に代表されるエッチング法ではネガパターンを採用すれば良い。

【００６５】また、図４および図５に示す予め回路パターンを形成しないで、導電層５及び導電物質４によって構成される表面を平滑に研削した後、回路パターンを形成する場合は、電着フォトレジスト膜を用いたＥＤ法で形成すると、レジスト膜を電気的に形成するため、ゴミ等の悪影響を受けず高精度で且つ信頼性の高い回路パターンが得られる。

【００６６】特に、ネガ型の電着フォトレジスト膜を用いると、スルーホール用貫通孔３が導電物質４で充填されているため、該スルーホール用貫通孔内を露光する必要がなく、０．３ｍｍ以下の小径のスルーホールを信頼性よく形成することができる。

【００６７】また、前記スルーホール部と表面回路パターン２或いは該スルーホール部周辺の導電層５との接続部分を覆うように硬化性導電物質を塗布して均一な厚みの導電パターン７を形成する方法としては、公知の印刷による導電パターンの製造方法が好適に採用される。具体的には、ディスペンサーを用いて必要な箇所に硬化性導電物質を塗布した後、硬化する方法や、スクリーン印刷機用いて印刷塗布した後、硬化する方法などが挙げられる。尚、前記した上記スルーホール部上の導体パターン７上に表面実装部品を直接接続する場合において、該部品を安定して搭載するために、表面実装部品を直接搭載するスルーホール部上以外の回路パターン上へ、該硬化性導電物質を塗布して均一な厚みの導電パターンを形成する場合においても、上記と同様な形成方法が採用され、通常、同時に行われる。

【００６８】上記スルーホール部と表面回路パターン２或いは該スルーホール部周辺の導電層５との接続部分を覆う硬化性導電物質の硬化は、前述のスルーホール用貫通孔３に充填された硬化性導電物質９の硬化方法と同様に、熱風炉、赤外線炉、遠赤外線炉、紫外線硬化炉、電子線硬化炉等の公知の硬化方法より、硬化性導電物質の硬化に適するものを適宜選んで硬化させれば良い。

【００６９】本発明においては、前述したように、スルーホール用貫通孔３に充填された導電物質４と表面回路パターン２或いは導電層５とが実質的に同一平面をなすように形成されているため、例えば、スクリーン印刷機を用いて硬化性導電物質を上記接続部分に塗布する場合、印刷時の滲みの発生がなく、その結果、作業性に優れ、しかも均一に硬化性導電物質を塗布することが可能となる。

【００７０】また、スルーホール部と表面回路パターン２の接続部分とに形成される導電パターン７の厚みが均一で且つ薄い。よって、前記した従来の導電物質をスルーホール用貫通孔の周囲に覆い被さるよう、導電物質を突出するように充填する手段では、表面回路パターン部と突出部に２回に分けて形成していたが、本発明によれば半田レジスト層の形成が１回で精度良く行うことが可能となった。

【００７１】また、図５に示す予め表面回路パターン２を形成しないで、導電層５及び導電物質４によって構成

される表面を平滑に研削した後、導電パターン７を形成し、表面回路パターン２を形成した場合、スルーホール用貫通孔３に充填された導電物質４の表面がエッチングレジストや、該エッチングレジストの剥離液等のアルカリ性溶液および表面処理用の酸洗液に曝されることがなく、該導電物質４の表面や該導電物質とランド部８との接続界面を汚染することがないため、信頼性のよいスルーホールを形成することができる。

【００７２】本発明において、表面回路パターン２或いは硬化性導電物質９、及び導電物質４によって構成される表面を平滑に研削し、導電パターン７を形成する方法において、片面を平滑に研削し、導電パターン７を形成した後、もう一方の面を研削し、導電パターン７を形成してもよい。

【００７３】従って、本発明の方法によれば、スルーホール部と回路パターンとの電気的接続を信頼性よく、確実に行うことができる。

【００７４】

【効果】以上の説明において明らかなように、本発明の回路基板は、化学鍍金、電気鍍金を行うことなく、しかも、スルーホール部と表面回路パターンの接続部分に形成される導電パターンの厚みが均一で、スルーホールの導通信頼性が高く、且つ表面実装部品の実装時の半田ペースト印刷が精度よく行え、表面実装部品の接続信頼性が高い。

【００７５】更に、本発明の製造方法によれば、スルーホール用貫通孔に充填、硬化された硬化性導電物質の表面が回路パターンと実質的に同一平面を有するため、後の工程であるスルーホール部と回路パターンの接続部分の硬化性導電物質による導電パターンの形成が、精度よく均一に行うことができる。

【００７６】したがって、本発明の回路基板は、従来の化学鍍金や電気鍍金をおこなった回路基板に比べて高歩留で、且つ実装密度や配線密度の高い回路基板である。

【００７７】

【実施例】以下、本発明を具体的に説明するために実施例を示すが、本発明はこれらの実施例に限定されるものではない。

【００７８】実施例１

スルーホール用貫通孔３に充填する硬化性導電物質９として、以下の組成の銅ペーストを用いた。即ち、バインダー成分として、エポキシ当量が１７３ｇ／当量のビスフェノールＡジグリシジルエーテルと該ビスフェノールＡジグリシジルエーテル１００重量部に対して、３５重量部のデシルグリシジルエーテルと、硬化剤としてノボラック型フェノール樹脂を３９重量部と、銅粉として平均粒径１０．５μｍの樹枝状銅粉を、バインダー１００重量部に対し３６０重量部添加し、更に、２－エチル－４－メチルイミダゾールを、バインダー１００重量部に対し２．８重量部加えたものを三本ロールで４５分間混練して銅ペーストを調製した。

【００７９】また、スルーホール部と回路パターンとの接続部分を覆うようにして形成される導電パターン７の硬化性導電物質としては、バインダーの主成分がレゾール型のフェノール樹脂であるタツタ電線（株）社製銅ペーストＮＦ－２０００を用いた。

【００８０】以下、前者のエポキシ樹脂をバインダーの主成分とする銅ペーストを「銅ペーストＡ」、後者のレゾール型のフェノール樹脂を主成分とするタツタ電線（株）製の銅ペーストＮＦ２０００を「銅ペーストＢ」として記載する。

【００８１】図３に示す工程に従って回路基板の製造を実施した。即ち、（ａ）絶縁基板１として両面に銅箔よりなる導電層５を有する厚さ１．２ｍｍのガラスエポキシ基板を用い、直径が０．６ｍｍのスルーホール用貫通孔３をドリリングにより１００穴設け、該絶縁基板の両面に幅５０μｍ、間隔５０μｍのラインおよびランド部を含む表面回路パターン２を形成し、（ｂ）該スルーホール用貫通孔に硬化性導電物質９として銅ペーストＡを上記表面回路パターンより０．２５ｍｍ突出するように、スクリーン印刷法により充填し、エアオーブンで５０℃－３０分、１８０℃－６０分の条件で硬化させた後、（ｃ）該表面回路パターン及び硬化性導電物質によって構成される表面を２００番のバフと３６０番のバフを順次使用して、平滑に研削して導電物質４が充填されたスルーホール部を形成した後、（ｄ）該スルーホール部の実質的全面と、該スルーホールに接続する表面回路パターン２の幅０．１ｍｍの辺縁部とを覆う硬化性導電物質として銅ペーストＢをスクリーン印刷法によって塗布して、エアーオーブンで１６０℃－３０分の条件で硬化して平均厚さ３０μｍ（±約１０％のバラツキ）の導電パターン７を形成し、両面回路基板を１００枚得た。

【００８２】得られた回路基板は、回路パターンの短絡および断線が発生せず、歩留まりは１００％だった。該回路基板について、回路基板の表裏に形成された導電パターン７間でスルーホールの抵抗値を測定したところ、平均で１５ｍΩ／穴であった。この回路基板を６０℃－９０％ＲＨの高温高湿条件で１０００時間曝した後、スルーホール抵抗値を再度測定すると、平均で１７ｍΩ／穴であった。また、上記回路基板は、基板表面の凸凹も少なく、表面実装部品の実装時における半田ペースト印刷も良好に行え、表面実装部品を信頼性よく接続することができた。

【００８３】実施例２

図４に示す工程に従って、回路基板の製造を実施した。即ち、（ａ）両面に銅箔よりなる導電層５を有する厚さ１．２ｍｍのガラスエポキシ基板の絶縁基板１に、直径が０．５ｍｍのスルーホール用貫通孔３をドリリングにより１００穴設け、（ｂ）該スルーホール用貫通孔３に硬化性導電物質９として銅ペーストＡをスクリーン印刷

法により充填し、エアオーブンで５０℃－３０分、１８０℃－６０分の条件で硬化させた後、（ｃ）該導電層及び硬化性導電物質によって構成される表面を２００番のバフと３６０番のバフを順次使用して、平滑に研削して導電物質４が充填されたスルーホール部を形成した後、（ｄ）次いで該導電層５にエッチングレジストを用いて、両面に幅５０μｍ、間隔５０μｍのラインおよびランド部を含む表面回路パターン２を形成した後、（ｅ）該スルーホール部の実質的全面と、該スルーホールに接続する表面回路パターン２の幅０．１ｍｍの辺縁部とを覆う硬化性導電物質として銅ペーストＢをスクリーン印刷法にて塗布して、エアーオーブン１６０℃－３０分の条件で銅ペーストＢを硬化し、平均厚さ２５μｍ（±約１０％のバラツキ）の導電パターン７を形成し、両面回路基板を１００枚得た。

【００８４】得られた回路基板は、回路パターンの短絡および断線が発生せず、歩留まりは１００％だった。該回路基板について、回路基板の表裏に形成された導電パターン７間でスルーホールの抵抗値を測定したところ、平均で１９ｍΩ／穴であった。この回路基板を６０℃－９０％ＲＨの高温高湿条件で１０００時間曝した後、スルーホール抵抗値を再度測定すると、平均で２２ｍΩ／穴であった。また、上記回路基板は、基板表面の凸凹も少なく、表面実装部品の実装時における半田ペースト印刷も良好に行え、表面実装部品を信頼性よく接続することができた。

【００８５】実施例３

図５に示す工程に従って、回路基板の製造を実施した。即ち、（ａ）両面に銅箔よりなる導電層５を有する厚さ１．２ｍｍのガラスエポキシ基板の絶縁基板１に、直径が０．５ｍｍのスルーホール用貫通孔３をドリリングにより１００穴設け、（ｂ）該スルーホール用貫通孔３に硬化性導電物質９として銅ペーストＡをスクリーン印刷法により充填し、エアオーブンで５０℃－３０分、１８０℃－６０分の条件で硬化させた後、（ｃ）該導電層及び硬化性導電物質によって構成される表面を２００番のバフと３６０番のバフを順次使用して、平滑に研削して導電物質４が充填されたスルーホール部を形成した後、（ｄ）該スルーホール部の実質的全面と、該スルーホールに接続する表面回路パターン２の幅０．１ｍｍの辺縁部とを覆う硬化性導電物質として銅ペーストＢをスクリーン印刷法にて塗布して、エアーオーブン１６０℃３０分の条件で銅ペーストＢを硬化し、平均厚さ２５μｍ（±約１０％のバラツキ）の導電パターン７を形成し、（ｅ）次いで該導電層５にエッチングレジストを用いて、両面に幅５０μｍ、間隔５０μｍのラインおよびランド部を含む表面回路パターン２を形成し、両面回路基板を１００枚得た。

【００８６】得られた回路基板は、回路パターンの短絡および断線が発生せず、歩留まりは１００％だった。該

回路基板について、回路基板の表裏に形成された導電パターン７間でスルーホールの抵抗値を測定したところ、平均で１８ｍΩ／穴であった。この回路基板を６０℃－９０％ＲＨの高温高湿条件で１０００時間曝した後、スルーホール抵抗値を再度測定すると、平均で１９ｍΩ／穴であった。また、上記回路基板は、基板表面の凸凹も少なく、表面実装部品の実装時における半田ペースト印刷も良好に行え、表面実装部品を信頼性よく接続することができた。

【００８７】実施例４

図４に示す工程に従って、回路基板の製造を実施し、最後にニッケル・金鍍金を施した。即ち、（ａ）両面に銅箔よりなる導電層５を有する厚さ１．２ｍｍのガラスエポキシ基板の絶縁基板１に、直径が０．５ｍｍのスルーホール用貫通孔３をドリリングにより１００穴設け、（ｂ）該スルーホール用貫通孔３に硬化性導電物質９として銅ペーストＡをスクリーン印刷法により充填し、エアオーブンで５０℃－３０分、１８０℃－６０分の条件で硬化させた後、（ｃ）該導電層及び硬化性導電物質によって構成される表面を２００番のバフと３６０番のバフを順次使用して、平滑に研削して導電物質４が充填されたスルーホール部を形成した後、（ｄ）次いで該導電層５にエッチングレジストを用いて、両面に幅５０μｍ、間隔５０μｍのラインおよびランド部を含む表面回路パターン２を形成した後、（ｅ）該スルーホール部の実質的全面と、該スルーホールに接続する表面回路パターン２の幅０．１ｍｍの辺縁部とを覆い、かつ表面実装部品を搭載するパッド部を覆うように硬化性導電物質として銅ペーストＢをスクリーン印刷法にて塗布して、エアーオーブン１６０℃－３０分の条件で銅ペーストＢを硬化し、平均厚さ２５μｍ（±約１０％のバラツキ）の導電パターン７を形成した後、該表面回路パターン上および該導電パターン上にニッケル鍍金４μｍ、金鍍金０．２μｍ施して、両面回路基板を１００枚得た。

【００８８】得られた回路基板は、回路パターンの短絡および断線が発生せず、歩留まりは１００％だった。該回路基板について、回路基板の表裏に形成された導電パターン７間でスルーホールの抵抗値を測定したところ、平均で１９ｍΩ／穴であった。この回路基板を６０℃－９０％ＲＨの高温高湿条件で１０００時間曝した後、スルーホール抵抗値を再度測定すると、平均で２０ｍΩ／穴であった。また、上記回路基板は、基板表面の凸凹も少なく、表面実装部品の実装時における半田ペースト印刷も良好に行え、表面実装部品を信頼性よく接続することができた。また、導電パターン上においても、表面実装部品を信頼性よく接続することができた。

【００８９】実施例５

絶縁基板の積層体を用い、図４に示す工程に従って、回路基板の製造を実施し、最後にニッケル・金鍍金を施した。即ち、（ａ）３枚の絶縁基板の積層体よりなり、絶

縁基板の間には銅箔よりなる回路パターンを有し、該積層体の両表面に銅箔よりなる導電層５を有する厚さ１．２ｍｍのガラスエポキシの絶縁基板の積層体に、直径が０．５ｍｍのスルーホール用貫通孔３をドリリングにより１００穴設け、（ｂ）該スルーホール用貫通孔３に硬化性導電物質９として銅ペーストＡをスクリーン印刷法により充填し、エアオーブンで５０℃－３０分、１８０℃－６０分の条件で硬化させた後、（ｃ）該導電層及び硬化性導電物質によって構成される表面を２００番のバフと３６０番のバフを順次使用して、平滑に研削して導電物質４が充填されたスルーホール部を形成した後、

（ｄ）次いで該導電層５にエッチングレジストを用いて、両面に幅５０μｍ、間隔５０μｍのラインおよびランド部を含む表表面回路パターン２を形成した後、

（ｅ）該スルーホール部と表面回路パターン２との接続部分を覆うように、かつ表面実装部品を搭載するパッド部を覆うように硬化性導電物質として銅ペーストＢをスクリーン印刷法にて塗布して、エアーオーブン１６０℃－３０分の条件で銅ペーストＢを硬化し、平均厚さ２５μｍ（±約１０％のバラツキ）の導電パターン７を形成した後、該回路パターン上および該導電パターン上にニッケル鍍金４μｍ、金鍍金０．２μｍ施して、多層回路基板を１００枚得た。

【００９０】得られた回路基板は、回路パターンの短絡および断線が発生せず、歩留まりは１００％だった。該回路基板について、回路基板の表裏に形成された導電パターン７間でスルーホールの抵抗値を測定したところ、平均で１９ｍΩ／穴であった。また、内層同士のスルーホールの抵抗値を測定したところ、２２ｍΩ／穴であった。この回路基板を６０℃－９０％ＲＨの高温高湿条件で１０００時間曝した後、回路基板表裏に形成された導体パターンのスルーホール抵抗値を再度測定すると、平均で２０ｍΩ／穴、内層同士のスルーホール抵抗値を再度測定すると、平均で２２ｍΩ／穴であった。また、上記回路基板は、基板表面の凸凹も少なく、表面実装部品の実装時における半田ペースト印刷も良好に行え、表面実装部品を信頼性よく接続することができた。また、導電パターン上においても、表面実装部品を信頼性よく接続することができた。

【００９１】比較例１

実施例１において、（ａ）～（ｂ）の工程により回路基板の製造を実施した。得られた回路基板に表面実装部品を実装するために、該回路基板に半田ペーストをスクリーン印刷法で印刷したが、半田ペーストはほとんど該回路基板には印刷されず、部品を実装することができなかった。また、得られた回路基板の表裏でスルーホールの抵抗値を測定したところ、平均で１７ｍΩ／穴であった。この回路基板を６０℃－９０％ＲＨの高温高湿条件で１０００時間曝した後、スルーホール抵抗値を再度測定すると、平均で９８ｍΩ／穴になり、抵抗値の上昇が顕著であった。

【００９２】比較例２

実施例３において、（ａ）～（ｃ）の工程により、スルーホール部を形成した後、スルーホール部と導電層の上に共通した鍍金層を形成し、次いで該鍍金層および該導電層５にエッチングレジストを用いて、両面に幅５０μｍ、間隔５０μｍのラインおよびランド部を含む表面回路パターン２を形成し、両面回路基板を１００枚得た。得られた回路基板は、回路パターンの短絡および断線が発生し、歩留まりは２７％だった。

【図面の簡単な説明】

【図１】 本発明の回路基板の代表的な態様を示す断面図である。

【図２】 本発明の回路基板の代表的な態様を示す断面図である。

【図３】 本発明の回路基板の代表的な製造方法示す工程図である。

【図４】 本発明の回路基板の代表的な製造方法示す工程図である。

【図５】 本発明の回路基板の代表的な製造方法示す工程図である。

【図６】 本発明の回路基板における導電パターンの代表的な態様を示す平面である。

【図７】 本発明の回路基板における導電パターンの代表的な態様を示す平面である。

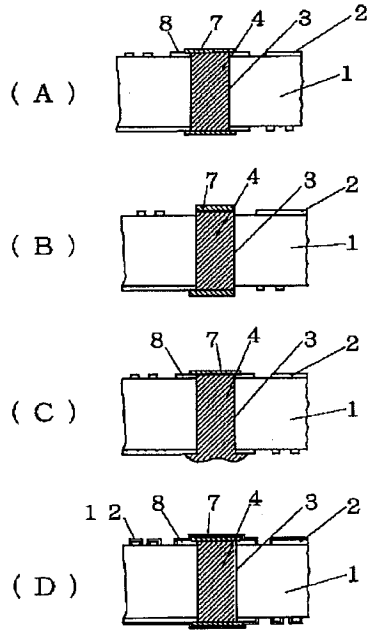
【図８】 本発明の回路基板における導電パターンの代表的な態様を示す平面である。

【符号の説明】

１　絶縁基板
２　表面回路パターン
３　スルーホール用貫通孔
４　導電物質
５　導電層
６　オーバーコート層
７　導電パターン
８　ランド部
９　硬化性導電物質
１１　絶縁基板の間に形成された回路パターン
１２　ニッケル・金鍍金層
１３　パッド部

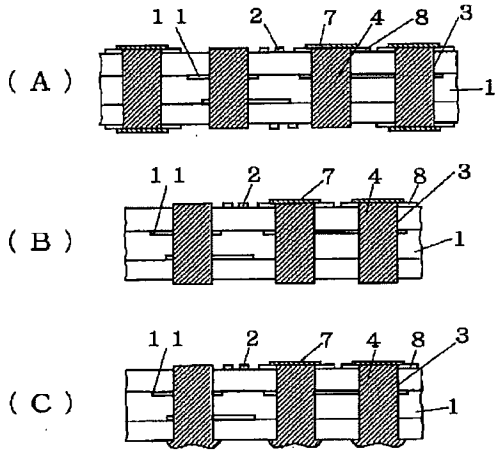
【図1】

図1



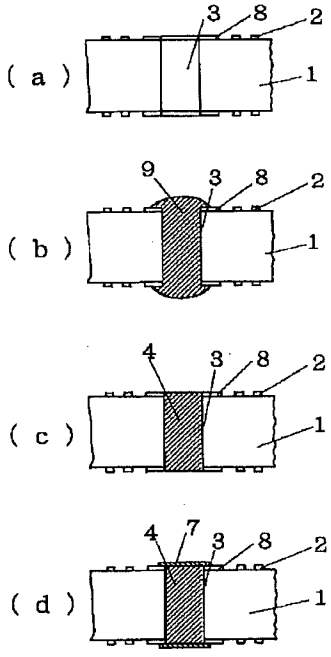
【図2】

図2



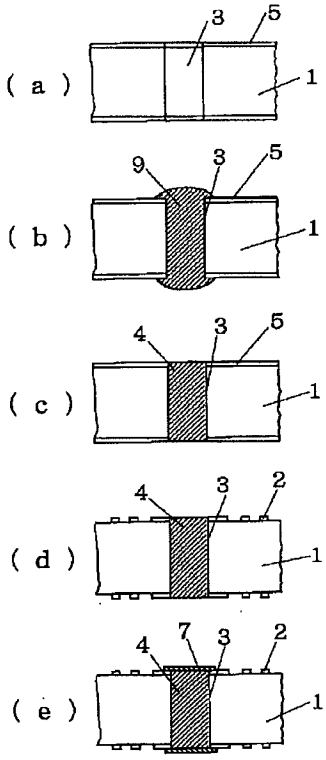
【図3】

図3



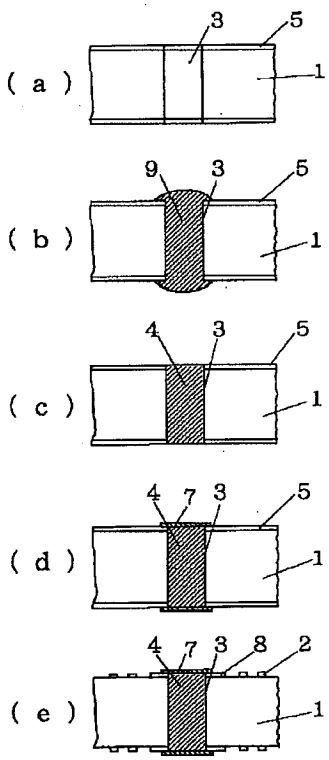
【図4】

図4



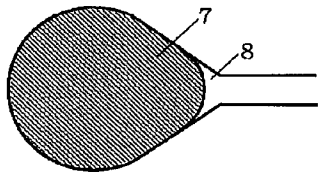
【図5】

図5



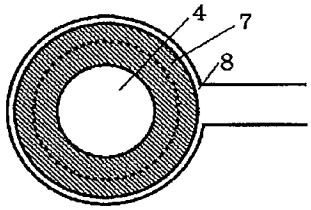
【図６】

図６



【図７】

図７



【図８】

図８